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Galton

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★ Dr. JOHN S. BILLINGS.
JUN 1913

ENGLISH MEN OF SCIENCE.

Dr. [illegible] S. [illegible]

ENGLISH

MEN OF SCIENCE:

THEIR NATURE AND NURTURE.

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BY

FRANCIS GALTON, F.R.S.,

AUTHOR OF "HEREDITARY GENIUS," ETC

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PREFACE.

I UNDERTOOK the inquiry of which this volume is the result, after reading the recent work of M. de Candolle,[1] in which he analyzes the salient events in the history of two hundred scientific men who have lived during the past two centuries, deducing therefrom many curious conclusions which well repay the attention of thoughtful readers. It so happened that I myself had been leisurely engaged on a parallel but more extended investigation—namely, as regards men of ability of all descriptions, with the view of supplementing at some future time my work on "Hereditary Genius." The object of that book was to assert the claims of one of what may be called the "preëfficients"[1] of eminent men, the importance of which had been previously overlooked; and I had yet to work out more fully its relative efficacy, as compared with those of education, tradition, fortune, opportunity, and much else. It was therefore with no ordinary interest that I studied M. de Candolle's work, finding in it many new ideas and much confirmation of my own opinions; also not a little criticism (supported, as I conceive, by very imperfect biographical evidence)[2] of my published views on heredity. I thought it best to test the value of this dissent at once, by limiting my first publication to the same field as that on which M. de Candolle had worked—namely, to the history of men of science, and to investigate their sociology from wholly new, ample, and trustworthy materials. This I have done in the present volume; and I am confident that one effect of the evidence here collected will be to strengthen the utmost claims I ever made for the recognition of the importance of hereditary influence.

---

[1] "Histoire des Sciences et des Savants depuis deux Siècles." Par Alphonse de Candolle. Corr. Inst. Acad. Sc. de Paris, etc. Genève, 1873.

---

[1] Or, "all that has gone to the making of." The word was sug- ed to me.

e may be made to a short review by me of M. de Can- he *Fortnightly Review*, March, 1873.

A few of my results, and some of the evidence on which they were based, were given by me at a Friday evening lecture, February, 1874, before the Royal Institution. I have incorporated parts of that lecture into this volume, with emendations and large additions.

It had been my wish to work up the materials I possess with much minuteness; but some months of careful labor made it clear to me that they were not sufficient to bear a more strict or elaborate treatment than I have now given to them.

The pleasant duty remains of acknowledging a debt to my friend, Mr. Herbert Spencer, for many helpful suggestions, and for his encouragement when I was planning this work; and to reiterate my deep sense of gratitude to numerous correspondents, which I have expressed elsewhere in the following pages.

I may add, that four of the scientific men who replied to my questions have passed away since I began to write. Of these, two had sent me complete returns, namely, Prof. Phillips, the geologist, and Sir William Fairbairn, the engineer. As regards the other two—Sir Henry Holland, the physician, had published his autobiography, but he gave me much help colloquially, and promised more; and Sir Edmund, better known as Count Strzelecki, the Australian traveler and meteorologist, furnished me with very suggestive information, but too incomplete for statistical use.

FRANCIS GALTON.

42 RUTLAND GATE, *November*, 1874.

P. S.—I have to apologize for some faults of style in the earlier pages, due to my not having had as full an opportunity as I had counted upon of correcting that portion of the press.

After I had sent the above to the printer, a friend happened to point out to me the following passage in the "Sartor Resartus" of Carlyle (book ii., ch. 2). It expresses sentiments so nearly akin to those which induced me to write this book, that I am glad to quote it:

> "It is maintained by Helvetius and his set, that an infant of genius is quite the same as any other infant, only that cer-
> rprisingly favorable influences accompany him through
> through childhood, and expand him, while oth-
> ed, and continue dunces. . . . With which
> dröckh, 'I should as soon agree as with

this other—that an acorn might, by favorable or unfavorable influences of soil and climate, be nursed into a cabbage, or the cabbage-seed into an oak. Nevertheless,' continues he, 'I, too, acknowledge the all-but omnipotence of early culture and nurture: hereby we have either a doddered dwarf bush, or a high-towering, wide-shadowing tree; either a sick yellow cabbage or an edible luxuriant green one. Of a truth, it is the duty of all men, especially of all philosophers, to note down with accuracy the characteristic circumstances of their education, what furthered, what hindered, what in any way modified it. . . .'"

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ENGLISH MEN OF SCIENCE.

CHAPTER I.

ANTECEDENTS.

Object of Book—Definition of Man of Science—Data—Nature and Nurture—Race and Birthplace—Occupation of Parents and Position in Life—Physical Peculiarities of Parents—Primogeniture, etc.—Fertility—Heredity—Pedigrees—Statistical Results.

THE intent of this book is to supply what may be termed a Natural History of the English Men of Science of the present day. It will describe their earliest antecedents, including the hereditary influences, the inborn qualities of their mind and body, the causes that first induced them to pursue science, the education they received and their opinions on its merits. The advantages are great of confining the investigation to men of our own period and nation. Our knowledge of them is more complete, and, where deficient, it may be supplemented by further inquiry. They are subject to a moderate range of those influences which have the largest disturbing power, and are therefore well fitted for statistical investigation; lastly, the results we may obtain are of direct practical interest. The inquiry is a complicated one at the best; it is advantageous not to complicate it further by dealing with notabilities whose histories are seldom autobiographical, never complete and not always very accurate; and who lived under the varied and imperfectly appreciated conditions of European life, in several countries, at numerous periods during many different centuries.

Definition of "Man of Science."—I do not attempt to define a "scientific man," because no frontier line or *definition* exists, which separates any group of individuals from the rest of their species. Natural groups have nuclei, but no outlines; they blend on every side with other systems whose nuclei have alien characters. A naturalist must construct his picture of Nature on the same principle that an engraver in mezzotint proceeds on his plate, beginning with the principal lights as so many different points of departure, and working outward from each of them until the intervening spaces are covered. Some definition of an ideal scientific man might possibly be given and accepted, but who is to
ide in each case whether particular individuals fall
he definition? It seems to me the best way to
rdict of the scientific world as expressed in
. It may be over-lenient in some cases,

in others it may never have been uttered, but on the whole it appears more satisfactory than any other verdict which exists or is attainable. To have been elected a Fellow of the Royal Society since the reform in the mode of election, introduced by Mr. Justice Grove nearly thirty years ago, is a real assay of scientific merit. Owing to various reasons, many excellent men of science of mature ages may not be Fellows, but those who bear that title cannot but be considered in some degree as entitled to the epithet of "scientific." I therefore look upon this fellowship as a "pass examination," so to speak, and from among the Fellows of the Royal Society I select those who have yet further qualifications. One of these is the fact of having earned a medal for scientific work; another, of having presided over a learned Society, or a section of the British Association; another, of having been elected on the council of the Royal Society; another, of being professor at some important college or university. These and a few other similar signs of being appreciated by contemporary men of science, are the qualifications for which I have looked in selecting my list of typical scientific men. I have only deviated from these technical rules in two or three cases, where there appeared good reason for their relaxation and where the returns appeared likely to be of peculiar interest. On these principles I drew up a list of 180 men; most of them were qualified on more than one count, and many on several counts. Also,

list appeared nearly exhaustive in respect to those men of mature age who live in or near London, since other private tests suggested few additions. As two of these tests have been proposed by several correspondents, it may be well to describe them. The one is the election of individuals, on account of their scientific eminence, to a certain well-known literary and scientific club, the name of which it is unnecessary to mention. The committee of this club have the power of electing annually, out of their regular turn, nine persons eminent for science, literature, art, or public services. The two or three men who have in each year received this coveted privilege on the ground of science now amount to a considerable number, and they are all on my list. Again, there are certain dining clubs in connection with the Royal Society, the one meeting on the afternoon of every evening that it meets, and the other more rarely, and there are about fifty members to each of these clubs, the same persons being in many instances members of both. The election to either of the clubs is a testimony of some value to the estimation of the scientific status of a man by his contemporaries; almost all their members are on my list. No doubt, many persons of considerable position living in Edinburgh, Dublin, and elsewhere at a distance from London, are not
g those with whose experiences I am about to deal.
is no objection; I do not profess or care to be
n my data, only desiring to have a sufficien-

cy of material, and to be satisfied that it is good so far as it goes, and a perfectly fair sample. I do not particularly want a list that shall include every man of science in England, but seek for one that is sufficiently extended for my purposes, and that contains none but truly scientific men, in the usual acceptation of that word.

However, I have made some further estimates, and conclude that an exhaustive list of men of the British Isles, of the same mature ages and general scientific status as those of whom I have been speaking, would amount to 300, but not to more.

Some of my readers may feel surprise that so many as 300 persons are to be found in the United Kingdom who deserve the title of scientific men; probably they have been accustomed to concentrate their attention upon a few notabilities, and to ignore their colleagues. It must, however, be recollected that all biographies, even of the greatest men, reveal numerous associates and competitors whose merit and influence were far greater than had been suspected by the outside world. Great discoveries have often been made simultaneously by workers ignorant of each other's labors. This shows that they had derived their inspiration from a common but hidden source, as no mere chance would account for simultaneous discovery. In illustration of this view it will suffice to mention a few of the great discoveries in this generation. That of photography is most intimate associated with the names of Niépce, Daguerre, and Talbot, who were successful in 1839 along different lines of research, but Thomas Wedgewood was a photographer in 1802, though he could not fix his pictures. As to the origin of species, Wallace is well known to have had an independent share in its discovery, side by side with the far more comprehensive investigations of Darwin. In spectrum analysis the remarks of Stokes were anterior to and independent of the works of Kirchhoff and Bunsen. Electric telegraphy has numerous parents, German, English, and American. The idea of conservation of energy has unnumbered roots. The simultaneous discovery of the planet Neptune on theoretical grounds by Leverrier and Adams is a very curious instance of what we are considering. In patent inventions the fact of simultaneous discovery is notoriously frequent. It would therefore appear that few discoveries are wholly due to a single man, but rather that vague and imperfect ideas, which float in conversation and literature, must grow, gather, and develop, until some more perspicacious and prompt mind than the rest clearly sees them. Thus, Laplace is understood to have seized on Kant's nebular hypothesis and Bentham on Priestley's phrase, "the greatest happiness of the greatest number," and each of them elaborated the idea he had so seized, into a system.

The first discoverers beat their contemporaries in point of time, and by doing so they become leaders of thought. They direct the intellectual energy of the day into the channels they opened; it would have run in other channels but for their labor. It is therefore due to them, not that Science progresses, but that her progress is as rapid as it is, and in the direction toward which they themselves have striven. We must neither underrate nor overrate their achievements. I would compare the small band of men, who have achieved a conspicuous scientific position, to islands, which are not the detached objects they appear to the vulgar eye, but only the uppermost portions of hills, whose bulk is unseen. To pursue this metaphor, the range of my inquiry dips a few fathoms below the level at which popular reputation begins.

It is of interest to know the ratio which the numbers of the leading scientific men bear to the population of England generally. I obtain it in this way: Although 180 persons only were on my list, I reckon, as already mentioned, that it would have been possible to have included 300 of the same ages, without descending in the scale of scientific position; also it appears that the ages of half of the number on my list lie between fifty and sixty-five, and that about three-quarters of these may be considered, for census comparisons, as English. I combine these numbers, and compare them with that of the male population of England and Wales, between the same limits of age, and find the required ratio to be about one in 10,000. What, then, are the conditions of nature, and the various circumstances and conditions of life—

which I include under the general name of nurture—which have selected that one and left the remainder? The object of this book is to answer this question.

DATA.

My data are the autobiographical replies to a very long series of printed questions addressed severally to the 180 men whose names were in the list I have described, and they fill two large portfolios. I cannot sufficiently thank my correspondents for the courteousness with which they replied to my very troublesome queries, the great pains they have taken to be precise and truthful in their statements, and the confidence reposed in my discretion. Those of the answers which are selected for statistical treatment somewhat exceed 100 in number. In addition to these, I have utilized several others which were too incomplete for statistical purposes, or which arrived late, but these also have been of real service to me; sometimes in corroborating, at others in questioning previous provisional conclusions. I wish emphatically to add, that the foremost members of the scientific world have contributed in full proportion to their numbers. It must not for a moment be supposed that mediocrity is unduly represented in my data.

Natural history is an impersonal result; I am therefore able to treat my subject anonymously, with the exception of one chapter in which the pedigrees of certain families are given.

NATURE AND NURTURE.

The phrase "nature and nurture" is a convenient jingle of words, for it separates under two distinct heads the innumerable elements of which personality is composed. Nature is all that a man brings with himself into the world; nurture is every influence from without that affects him after his birth. The distinction is clear: the one produces the infant such as it actually is, including its latent faculties of growth of body and mind; the other affords the environment amid which the growth takes place, by which natural tendencies may be strengthened or thwarted, or wholly new ones implanted. Neither of the terms implies any theory; natural gifts may or may not be hereditary; nurture does not especially consist of food, clothing, education, or tradition, but it includes all these and similar influences whether known or unknown.

When nature and nurture compete for supremacy on equal terms in the sense to be explained, the former proves the stronger. It is needless to insist that neither is self-sufficient; the highest natural endowments may be starved by defective nurture, while no carefulness of nurture can overcome the evil tendencies of an intrinsically bad *physique*, weak brain, or brutal disposition

Differences of nurture stamp unmistakable marks on the disposition of the soldier, clergyman, or scholar, but are wholly insufficient to efface the deeper marks of individual character. The impress of class distinctions is superficial, and may be compared to those which give a general resemblance to a family of daughters at a provincial ball, all dressed alike, and so similar in voice and address as to puzzle a recently-introduced partner in his endeavors to recollect with which of them he is engaged to dance; but an intimate friend forgets their general resemblance in the presence of the far greater dissimilarity which he has learned to appreciate. There are twins of the same sex so alike in body and mind that not even their own mothers can distinguish them. Their features, voice, and expressions, are similar; they see things in the same light, and their ideas follow the same laws of association. This close resemblance necessarily gives way under the gradually accumulated influences of difference of nurture, but it often lasts till manhood. I have been told of a case in which two twin brothers, both married, the one a medical man, the other a clergyman, were staying at the same house. One morning, for a joke, they changed their neckties, and each personated the other, sitting by his wife through the whole of the breakfast without discovery. Shakespeare was a
en observer of nature; it is, therefore, worth recol-
at he recognizes in his thirty-six plays three
likeness so deceptive as to create absurd

confusion. Two of these pairs are in the "Comedy of Errors," and the other in "Twelfth Night" (v., 1). I heard of a case not many years back in which a young Englishman had traveled to St. Petersburg, then much less accessible than now, with no letters of introduction, and who lost his pocket-book, and was penniless. He was walking along the quay in some despair at his prospects, when he was startled by the cheery voice of a stranger who accosted him, saying he required no introduction because his family likeness proclaimed him to be the son of an old friend. The Englishman did not conceal his difficulties, and the stranger actually lent him the sum he needed on the guarantee of his family likeness, confirmed, no doubt, by some conversation. In this and similar instances how small has been the influence of nurture! the child had developed into manhood, along a predestined course laid out in his nature. It would be impossible to find a converse instance in which two persons, unlike at their birth, had been moulded by similarity of nurture into so close a resemblance that their nearest relations failed to distinguish them. Let us quote Shakespeare again as an illustration; in "A Midsummer-Night's Dream" (iii., 2), Helena and Hermia, who had been inseparable in childhood and girlhood, and had identical nurture—

"So we grew together,
Like to a double cherry, seeming parted,
But yet a union in partition"—

were physically quite unlike: the one was short and dark, the other tall and fair; therefore the similarity of their nurture did not affect their features. The moral likeness was superficial, because a sore trial of temper, which produced a violent quarrel between them, brought out great dissimilarity of character. In the competition between nature and nurture, when the differences in either case do not exceed those which distinguish individuals of the same race living in the same country under no very exceptional conditions, nature certainly proves the stronger of the two.

RACE AND BIRTHPLACE.

As regards the race of the scientific men on my list, it has already been mentioned that for the purposes of a census enumeration three-fourths may be considered English, but their precise origin is as follows: Omitting a few Germans, out of every 10 scientific men, 5 are pure English; 1 is Anglo-Welsh; 1 is Anglo-Irish; 1 is pure Scotch; 1 includes Anglo-Scotch, Scotch-Irish, pure Irish, Welsh, Manx and Channel Islands; finally, 1 is "unclassed." These unclassed are of extremely mixed origin. One is in about equal degrees English, Irish, French, and German; another is English, Scotch-creole, and Dutch; another English, Dutch-creole, and Swedish; and so on. (I trust the reader knows what les" are—namely, the descendants of white families long settled in a tropical colony; and that he does not confound the term with "mulattoes.") I give this information without being able to make much present use of it. It is chiefly intended to serve as a standard with which other natural groups may hereafter be compared, such as groups of artists or of literary men.

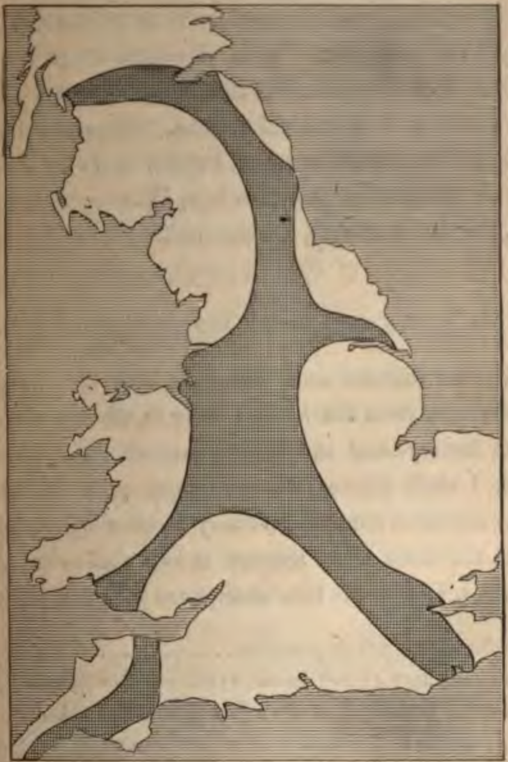
One would desire to know whether persons in England generally show so great a diversity of origin; but it is somewhat difficult to answer the question, owing to a want of precision in the word "generally." If we were to go to rural districts, or small stagnant towns, we should find much less variety of origin; but I think there would be quite as much in the more energetic classes of the metropolis, who have immigrated from all quarters. Some haphazard selecting which I tried confirmed this view. Then comes the important question, Is this a sign that a mixture of one or more of the various civilized races is conducive to form an able offspring? No doubt the varied "nurture" due to separate streams of tradition has great influence in awakening original thought, but we are not speaking of this now; the question is about "nature." On an analysis of the scientific status of the men on my list, it appeared to me that their ability is higher in proportion to their numbers among those of pure race. The Border men and Lowland Scotch come out exceedingly well; the Anglo-Irish and Anglo-Welsh, notwithstanding eminent individual exceptions, would as a whole rank la

Owing to my list not being exhaustive, I hardly like to attempt conclusions as to the precise productiveness of scientific ability of the Scotch, English, and Irish severally, but there cannot be a shadow of doubt that its degrees are in the order I have named.

The birthplaces of scientific men and of their parents are usually in towns, away from the sea-coast. Out of every 5 birthplaces I find that 1 lies in London or its suburbs; 1 in an important town, such as Edinburgh, Glasgow, Dublin, Birmingham, Liverpool, or Manchester; 1 is in a small town; and 2 either in a village or actually in the country. These returns are given with more detail in the foot-note.[1] The branch of science pursued is often in curious disaccord with the surrounding influence of the birthplace. Mechanicians are usually hardy lads born in the country, biologists are frequently pure townsfolk. Partly in consequence of the prevalence of their urban distribution I find that an irregular plot may be marked on the map of England which includes much less than one-half of its area, but more than 92 per cent. of the birthplaces of the English scientific men or of their parents. The accompanying diagram shows its position; one thin arm abuts on the sea between Hastings and Folkestone, and runs northward over London and Birmingham, where it is joined

---

[1] London, 16; suburbs, 5; = 21. Edinburgh and Glasgow, 7; Cork, Belfast, and Dublin, 6; Birmingham, Liverpool, and Manches[illegible]; total = 18. Smaller towns, 21; elsewhere, 40. General



by another thin arm proceeding from Cornwall and Devonshire, crossing the Bristol Channel to Swansea, and thence to Worcester. The two arms are now combined into one of double breadth; it covers Nottingham, Shrewsbury, Liverpool, and Manchester. Above these latitudes it again narrows, and after sending a small branch to Hull, proceeds northward to Newcastle, Edinburgh, and Glasgow. Thus there are large areas in England and Wales outside this irregular plot which are very deficient in aboriginal science. One comprises the whole of the eastern counties, another includes the huge triangle at whose angles Hastings, Worcester, and Exeter, or rather Exmouth, are situated.

OCCUPATION OF PARENTS AND POSITION IN LIFE.

My list contains men who have been born in every social grade, from the highest order in the peerage down to the factory-hand and simple peasant, but the returns which I shall discuss do not range quite so widely. These are 96 in number, and may be classified as follows—but the same name appears in two classes on eleven occasions, so that the total entries are raised to 107:

Noblemen and private gentlemen....................	9
Army and navy, 6; civil service, 9; subordinate officers, 3	18
Law, 11; medical, 9; clergy and ministers, 6; teachers, 6; architect, 1; secretary to an insurance-office, 1...	34
Bankers, 7; merchants, 21; manufacturers, 15........	43
Farmers..	2
Others...	1
	107

The terms used in the third and fourth groups must be understood in a very general sense; thus, there are some "merchants" on a very small scale indeed, and others on a very large one.

It is by no means the case that those who have raised themselves by their abilities are found to be abler than their contemporaries who began their careers with advantages of fortune and social position. They are not more distinguished as original investigators, neither are they more discerning in those numerous questions, not strictly scientific, which happen to be brought before the councils of scientific societies. There can be no doubt but that the upper classes of a nation like our own, which are largely and continually recruited by selections from below, are by far the most productive of natural ability. The lower classes are, in truth, the "residuum."

Of the 6 clergymen or ministers who were fathers of scientific men, no less than 4 appear in a second category, viz., (1) clergyman and school-master; (2) physician, afterward clergyman; (3) Unitarian minister and school-master; (4) professor of classics, afterward an Independent minister. Among the successful graduates of Oxford and Cambridge, and among purely literary men, we find a much larger proportion of sons of clergymen. There is at Cambridge a well-known university scholarship, called the "Bell," which is open only to sons of clergymen of the Church of England. As it has been chiefly given for classical proficiency, we may be almost sure that the senior classic of his year, if he were the son of a clergyman, would also be a Bell scholar. I looked through the lists, and found that out of 45 senior classics (1824–'68 inclusive) 10 had gained the scholarship, whence I conclude that at least 1 out of every 4 or 5 Cambridge graduates is the son of a clergyman. At this rate, out of 100 Cambridge graduates, 22 would have had clergymen of the Church of England for their fathers, whereas out of 100 scientific men only 3 or 4 were so circumstanced. It is therefore a fact that, in proportion to the pains bestowed on their education generally, the sons of clergymen rarely take a lead in science. The pursuit of science is uncongenial to the priestly character. It has fallen to my lot to serve for many years on the councils of many scientific societies, and, excepting a very few astronomers and mathematicians, about whom I will speak directly, I can only recall 3 colleagues who were clergymen; curiously enough, 2 of these, the Revs. Baden Powell and Dunbar Heath, have been prosecuted for unorthodoxy; the third was Bishop Wilberforce, who can hardly be said to have loved science; he rarely attended the meetings, but delighted in administration, and sought openings for indirect influence. The reason for the abstinence of clergymen from scientific work cannot be that they are too busy, too much home-tied, or cramped in pecuniary means, because other professional men, more more at the call of others, and having less assured revenues, are abundantly represented on all the council lists.

Not caring to trust my unaided recollections, I have examined the council lists of ten scientific societies, at or near the three periods, 1850, 1860, 1870. There have been changes in some of the societies, and there are many trifling peculiarities of detail, tedious and unnecessary here to deal with, but the following statement is substantially correct. The ordinary members of council are on a rough general average 20 in number to each of the following societies: (1) Royal; (2) British Association; (3) Astronomical; (4) Chemical; (5) Geological; (6) Linnæan; (7) Zoological; (8) Geographical; (9 and 10) the two predecessors of the recently-established Anthropological Institute, viz., Ethnological and Anthropological; (11) Statistical. Therefore as we are dealing with 3 distinct periods, 11 societies, and 20 members of council to each, there have been about (3 × 11 × 20 =) 660 separate appointments. Clergymen have held only 16 of these, or 1 in 40; and they have in nearly every case been attached to those subdivisions of science which have fewest salient points to scratch or jar against dogma. Thus Prof. Challis, Dr. Lloyd, Dr. Robinson, Dr. Whewell, Rev. J. Fisher, Rev. W. Webb, Rev. Vernon Harcourt, Prof. Pritchard, Prof. Price, Rev. J. Barlow, and Prof. Willis, are all chiefly connected with astronomy, physics, and mathematics; the five remaining names are those of the

G. C. Renouard, the geographer; Bishop Wilberforce, and the Rev. Dunbar Heath, of whom I have already spoken; the Rev. Dr. Nicholson, and the Rev. Canon Greenwell: there is not a single biologist among them.

PHYSICAL PECULIARITIES OF PARENTS.

It has been frequently asserted that certain physical peculiarities in the parents clash, and that others combine happily in the offspring. I therefore thought it well to make inquiries as to the figure, complexion, color of hair, height, and other physical peculiarities of the fathers and mothers of the scientific men. I also asked about the temperaments, if they were marked, but the answers to these were few.

Tables showing the number of cases in which there has been harmony, indifference, or contrast, between various physical peculiarities of the two parents.

TEMPERAMENTS OF PARENTS.

(h = harmony, c = contrast.)

MOTHERS.	FATHERS.			
	Nervous.	Sanguine.	Bilious.	Lymphatic.
Nervous	h. 6	5	....	c. 0
Sanguine	1	h. 3	....	c. 0
Bilious	4	....	h. 1	....
Lymphatic	c. 0	c. 2	....	h. 0

ary—Harmony, 10 cases; contrast, 2; indifferent, 10. Total, 22.

COLOR OF HAIR OF PARENTS.

(h = harmony, c = contrast.)

MOTHERS.	FATHERS.						
	Black.	Dark.	Dark Brown.	Brown.	Light Brown.	Light.	Fair.
Black	h. 2	h. 2	h. 1	1	c. 0	c. 1	c. 0
Dark	h. 2	h. 5	h. 1	2	2	c. 1	c. 1
Dark Brown	0	h. 2	h. 4	h. 3	3	0	c. 0
Brown	3	4	h. 2	h. 14	h. 1	0	1
Light Brown	c. 0	2	2	h. 1	h. 0	h. 0	0
Light	c. 3	c. 0	0	2	h. 0	h. 2	h. 0
Fair	c. 0	c. 0	c. 0	0	h. 1	h. 0	h. 1

Summary—Harmony, 44 cases; contrast, 6; indifferent, 22.
Total, 72.

I have, in addition, 11 cases of colored hair—yellowish, sandy, red, light auburn, dark auburn, chestnut—but not one case of strict harmony among them.

FIGURE OF PARENTS OF SCIENTIFIC MEN.

(h = harmony, c = contrast.)

MOTHERS.	FATHERS.				
	Corpulent, stout, or plump.	Muscular, robust, strong.	Compact, symmetrical, stately.	Spare, neat, small.	Medium.
Corpulent, stout, or plump......	h. 3	h. 5	0	c. 7	c. 1
Muscular, robust, strong	h. 0	h. 2	1	c. 1	0
Compact, symmetrical, stately ...	3	2	h. 2	6	0
Spare, neat, small.	c. 9	c. 5	4	h. 12	1
Medium.........	0	1	1	5	h. 0

Summary—Harmony, 24 cases; contrast, 23; indifferent
Total, 71.

The foregoing tables show results bearing on the question whether harmony or contrast prevails in the physical characteristics of the parents. I think they must be accepted as decidedly in favor of harmony. The grand totals which they give are 78 cases of harmony, 31 of contrast, and 56 of indifference. In short, there is more purity of breed in scientific men than would have resulted from haphazard marriages. In the temperaments of their parents, harmony strongly prevails over contrast, the proportion being 5 to 1 in favor of the former. In color of hair, harmony is twice as frequent as contrast. In figure it is equally common, because "corpulent, stout, or plump" persons of one sex seem to have a peculiar and reciprocated liking for "spare, neat, or small" persons of the other. This is literally the only case in these tables where a love of contrast equals that of harmony. I came to much the same conclusions by giving appropriate marks for harmony, contrast, and indifference, to each quality in each case, thus obtaining aggregate marks for every pair, which I have treated on much the same principle that the separate qualities are treated in the table. As regards height, there is a stricter method of investigation, which statisticians will appreciate. It is well known, by repeated experience, that the heights of men and of women in any large group are distributed according to the "law of frequency of error." In other words, the oportionate number of people of different heights corresponds to what would have been the case supposing stature to be due to the *aggregate action of many small and independent variable causes.* The probability is inconceivably small that all the independent causes should in any given case coöperate to produce an excess of height; if they did so, the result would be a Brobdignagian giant; or that they should all coöperate to produce a deficiency in height, in which case the result would be a Liliputian dwarf. On the other hand, the probability is great that the number and effects of the causes in excess and those in deficiency of their several average values will be pretty equal. As for these and all other intermediate cases, their relative frequency is determined by the above law, which is based on that by which the relative frequency of different "runs of luck" is calculated.

I now proceed to apply this law. I have 62 cases in which the heights of both parents are given numerically, whence it appears that—(1) the average height of the fathers is between 5 ft. 9 in. and 5 ft. 9¼ in., and that their distribution conforms closely to the law of frequency of error, the "probable error" of the series being 1.7 in. (2) The average height of the mothers is 5 ft. 4½ in., and the distribution of their heights conforms fairly to the above-mentioned law, the "probable error" of the series being 1.9 in. It follows, from the well-known properties of the law in question, that if there had been no sexual selection in respect of height, the sum of the heights of the two parents would also conform to the law of frequency of error, and that the probable error of the series would be $\sqrt{(1.7)^2 + (1.9)^2} = 2.5$ in. (3) I find that the heights in question do conform pretty closely to the law in question, and that the probable error of the series is 2.3 in., which differs so slightly from the value obtained by calculation, on the supposition of there having been no sexual preference for contrast in height, that we may safely affirm in this case also, that the love of contrast does not prevail over that of harmony.[1]

It is a question of high importance to speculations on the future of our race, whether the instincts of sexual selection are or are not repugnant to an improvement in the human breed. We know perfectly well that they are repugnant to unions where the resemblance is very close; thus near intermarriages shock our feelings, and the maintenance of high-bred artificial varieties in their purity is always effected with difficulty among animals. On the other hand, they are equally repugnant to unions in which there is great contrast;

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[1] The series of facts in (1), (2), and (3), and the corresponding figures given by the theory with which they are supposed to conform, are as follows:

	(1) FATHER.	(2) MOTHER.	(3) BOTH PARENTS.
	3 15 20 30 18 3 2	5 14 32 29 11 6 3	3 18 34 26 13 5 1
	5 15 27 29 18 5 1	8 18 25 26 15 6 2	6 18 31 29 13 2 1

thus, the intermarriage of white and black races rarely takes place, and animals of different species refuse to cross. Where, then, and how wide, is the belt that lies between close harmony and wide contrast, in which sexual instinct acts most powerfully? It appears from the facts in this chapter, that the marriages of parents of the scientific men on my list actually tended to produce differentiation and purity of race. My data concerning the parents of men of other groups are insufficient to enable me yet to give comparative results showing how far the selective sexual instincts of the population generally would thwart, be indifferent to, or coöperate with the influences of future social restrictions on unsuitable marriages, or encouragement of suitable ones.

PRIMOGENITURE, ETC.

The following statement shows, in percentages, the position of the scientific men in respect to age among their brothers and sisters:

Only sons, 22 cases; eldest sons, 26 cases; youngest sons, 15 cases. Of those who are neither eldest nor youngest, 13 come in the elder half of the family; 12 in the younger half; and 11 are exactly in the middle. Total, 99.

It further appears that, at the time of the birth of the scientific men, the ages of their fathers average 36 years, and those of their mothers 30. The details are shown in the table below:

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Lymphatic	c. 0	c. 2	....	h. 0

Summary—Harmony, 10 cases; contrast, 2; indifferent, 10.
Total, 22.

COLOR OF HAIR OF PARENTS.

(h = harmony, c = contrast.)

MOTHERS.	FATHERS.						
	Black.	Dark.	Dark Brown.	Brown.	Light Brown.	Light.	Fair.
Black ……	h. 2	h. 2	h. 1	1	c. 0	c. 1	c. 0
Dark ……	h. 2	h. 5	h. 1	2	2	c. 1	c. 1
Dark Brown	0	h. 2	h. 4	h. 3	3	0	c. 0
Brown ….	3	4	h. 2	h. 14	h. 1	0	1
LightBrown	c. 0	2	2	h. 1	h. 0	h. 0	0
Light ……	c. 3	c. 0	0	2	h. 0	h. 2	h. 0
Fair ……	c. 0	c. 0	c. 0	0	h. 1	h. 0	h. 1

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MOTHERS.	FATHERS.				
	Corpulent, stout, or plump.	Muscular, robust, strong.	Compact, symmetrical, stately.	Spare, neat, small.	Medium.
Corpulent, stout, or plump……	h. 3	h. 5	0	c. 7	c. 1
Muscular, robust, strong ……..	h. 0	h. 2	1	c. 1	0
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It further appears that, at the time of the birth of the scientific men, the ages of their fathers average 36 years, and those of their mothers 30. The details shown in the table below:

No. of Cases.	AGE OF PARENTS AT BIRTH OF SCIENTIFIC MEN.								Total Cases.
	Under 20	20–	25–	30–	35–	40–	45–	50 and above.	
Fathers	0	1	15	34	22	17	7	4	100
Mothers	2	20	26	34	12	5	1	—	100

Putting these facts together, viz.—(1) that elder sons appear nearly twice as often as younger sons; (2) that, as regards intermediate children, the elder and younger halves of the family contribute equally; and (3) that only sons are as common as eldest sons—we must conclude that the age of the parents, within the limits with which we chiefly have to deal, has little influence on the nature of the child; secondly, that the elder sons have, on the whole, decided advantages of nurture over the younger sons. They are more likely to become possessed of independent means, and therefore able to follow the pursuits that have most attraction to their tastes; they are treated more as companions by their parents, and have earlier responsibility, both of which would develop independence of character; probably, also, the first-born child of families not well-to-do in the world would generally have more attention in his infancy, more breathing-space, and better nourishment, than his younger brothers and sisters in their several ns.

opposing disadvantage of primogeniture, in producing less healthy children and half as many idiots again as the average of the rest of the family, has not been sensibly felt, partly because the latter risk is very small, and partly because the mothers of the scientific men are somewhat less youthful than those from whom the above statistical results were calculated. (*See* Duncan "On Fertility," etc., second edition, pp. 293, 294, for tabulations of Dr. A. Mitchell's results.) An unusual number of the mothers of the scientific men were between thirty and thirty-four at the time of their birth; this is a very suitable age, according to the views of Aristotle, but undoubtedly older than what Dr. Duncan's statistics (pp. 387, 390) recommend. According to these, the most favorable period for the survival of mother and child, and therefore probably the best in every sense, is when she is twenty to twenty-five at the time of giving birth. The important question of the effect of the age of the parent on the well-being of the offspring seems never yet to have been treated as strictly and as copiously as it deserves. Dr. Duncan, in the chapter of his work above referred to, has discussed the materials at his disposal with great ingenuity and industry; but adequate statistics, sorted according to the various classes of society, are still wanting.

FERTILITY.

The families are usually large to which scientific men belong. I have two sets of returns—the one of brothers and sisters, excluding, for the most part, those who died in infancy; and the other of brothers and sisters who attained thirty years. In these several cases I have included the scientific man himself, and find, on an average of about 100 cases, that the total number of brothers and sisters is 6.30 in the first case, and 4.80 in the second. It is a matter of great interest to compare with these figures the number of the children of the scientific men themselves. It is easy to do so with fairness, because the time of marriage proves to be nearly the same in both cases; if any thing, the scientific men marry earlier than their parents. It remains to eliminate all cases of absolutely sterile marriages on the part of the scientific men, and those in which there might yet be other children born. Having attended to these precautions, I find the number of their *living* children (say, of ages between five and fifty) to be 4.7. This implies a diminution of fertility as compared with that of their own parents, and confirms the common belief in the tendency to an extinction of the families of men who work hard with the brain. On the other hand, I shall show that the health and energy of the scientific men are remarkably high; it therefore seems strange that there should be a falling off in their offspring. I have tried in many ways to find characteristics common to those scientific men whose families were the smallest, but have only lighted upon one general result, which I give provisionally, namely, that a *relative* deficiency of health and energy, in respect to that of their own parents, is very common among them. Their absolute health and energy may be high, far exceeding those of people generally; but I speak of a noticeable falling off from the yet more robust condition of the previous generation: it is this which appears to be dangerous to the continuance of the race. My figures give the remarkable result that there are no children at all in one out of every three of these cases. I think that ordinary observation corroborates this conclusion, and that those of my readers who happen to have mixed much in what is called intellectual society will be able to recall numerous instances of persons of both sexes, but especially of women, possessed of high gifts of every kind, including health and energy, but of less solid vigor than their parents, and who have no children. I do not overlook the fact that the scientific men are an urban population, being mindful of results I have published elsewhere (*Statistical Journal*, 1873), which show a similar diminution in the average fertility of townsmen as compared with country-folk; but this would not account for their being less prolific than their parents who were also townsmen, nor for the large number of wholly sterile marriages.

HEREDITY.

The effects of education and circumstances are so interwoven with those of natural character in determining a man's position among his contemporaries, that I find it impossible to treat them wholly apart. Still less is it possible completely to separate the evidences relating to that portion of a man's nature which is due to heredity, from all the rest. Heredity and many other coöperating causes must therefore be considered in connection; but I feel sure that as the reader proceeds, and becomes familiar with the variety of the evidence, he will insensibly effect for himself much of the required separation. Also, from time to time, as opportunity may offer, I shall attempt to draw distinctions.

The study of hereditary form and features in combination with character promises to be of much interest, but it proves disappointing on trial, owing to the impossibility of obtaining good historical portraits. The value of these is further diminished by the passion of distinguished individuals to be portrayed in uniforms, wigs, robes, or whatever voluminous drapery seems most appropriate to their high office, forgetting that all this conceals the man. The practice might well become common of photographing the features from different points of view, and at different periods of life, in such a way as would be most advantageous to a careful study of the lineaments of the man and his family. The interest that would attach to collections of these in after-times might be extremely great.

PEDIGREES.

Thirteen families have been selected, out of those to which about 120 of the scientific men on my list belong, as appearing noteworthy for their richness in ability during two, three, or more generations, or for any other peculiarity; in some cases they are also remarkable for purity of type. The facts may for the most part be verified by reference to the publications of which the titles are given; and the whole could have been obtained by any one who cared to search other more or less public sources of information. Five of these families (Bentham, Darwin, Dawson-Turner, Roscoe, and Taylor of Ongar) have already been alluded to in my previous work ("Hereditary Genius"), whence I have extracted what appeared to the point, adding what was necessary. In estimating the number of individuals in each generation, the practice has been usually adopted of not counting those who died young, or have not yet attained their thirtieth year.

Alderson.—Many members of this family have been intellectually gifted. There has been an unusual number of cases of mathematical achievement among them.

First Generation.—5 males and 2 females, children of the Rev. J. Alderson and his wife (the latter lived to 94). Of these, 3 males deserve notice: (1) James

Alderson, M. D., of Norwich; (2) Robert Alderson, Recorder of Norwich, Ipswich, and Yarmouth; (3) John Alderson, founder and president of all the literary and scientific institutions of the time in Kingston-upon-Hull. All these were men of considerable local repute.

Second Generation.—15 males and 12 females, of whom 5 males and 1 female deserve especial mention: (1) Sir Edward Hall Alderson, Baron of the Exchequer, who was the first man of his year at Cambridge, both in mathematics and classics, being senior wrangler and senior classical medallist, a distinction barely equaled in the long annals of university achievement; (2) Robert Woodhouse, also a senior wrangler, Lucasian and Plumian Professor of Astronomy at Cambridge; (3) the Rev. Samuel H. Alderson, third wrangler, and tutor of Caius College; (4) Sir James Alderson, M. D., F. R. S. (sixth wrangler), for four years President of the Royal College of Physicians; (5) Colonel Ralph Alderson, R. E., a distinguished officer, and one of the first government commissioners of railways; (1) Mrs. Amelia Opie, the novelist.

Third Generation.—I have not sufficient information, although I know that it includes many persons of ability, among whom is Major H. Alderson, R. A., a distinguished officer; also a married lady of high artistic powers.

ENTHAM.—A family consisting of only 3 male rep-
ves, all eminent, and one illustrious.

First Generation.—2 brothers: (1) Jeremy Bentham, jurist of the highest rank (life by Sir J. Bowring, prefixed to the collected works edited by him); (2) General Sir Samuel Bentham, whose early manhood was spent in the Russian service; distinguished for his numerous administrative reforms and singular inventive power. Afterward inspector-general of naval works in England (life by his widow, 1862).

Second Generation.—1 male only: George Bentham, F. R. S., systematic botanist of the highest rank; in early life, writer on logic; for many years President of the Linnæan Society.

CARPENTER.—Among the characteristics of this family are literary and scientific enterprise, philanthropic effort, nonconformity, and aptitude for oral exposition.

First Generation.—Rev. Lant Carpenter, LL. D., Unitarian minister; descended from a non-subscribing Presbyterian family, and married to a wife of similar descent; a leading member of the Liberal party in Exeter and Bristol; extremely active in the promotion of philanthropic objects; both literary and scientific in his studies, and a man of local celebrity (memoirs by his son, 1842).

Second Generation.—2 males and 3 females, of whom both the males and 1 female require notice: (1) William B. Carpenter, F. R. S., Registrar of the London University, physiologist, and frequent writer and speaker on scientific subjects, in many cases connected with social amelioration; (2) Dr. P. P. Carpenter (of Montreal) conchologist; actively engaged in philanthropic work; (1) Mary Carpenter, actively engaged in the foundation and organization of philanthropic institutions, especially juvenile reformatories, and promoter of female education in India.

Third Generation (too young for special notice) includes an influential dissenting minister and a very successful student.

Darwin.—There are many instances in this family of a love for natural history and theory, and of an aptitude for collecting facts in business-like but peculiar ways. Speaking from private sources of knowledge, I am sure that these characteristics are hereditary rather than traditional; there is also a strong element of individuality in the race which is adverse to traditional influence.

First Generation.—(1) Erasmus Darwin, M. D., F. R. S., physician, physiologist, and poet. His "Botanic Garden" had an immense reputation at the time it was written; for, besides its intrinsic merits, it chimed in with the sentiments and mode of expression of his day. The ingenuity of Dr. Darwin's numerous writings and theories is truly remarkable. He was held in very high esteem by his scientific friends, including such brities as Priestley and James Watt, and it is by a man's position among his contemporaries and competitors that his worth may most justly be appraised. Unfortunately for his memory, he has had no good biographer. He was a man of great vigor, humor, and geniality (Miss Seward's life of him, and latterly a pamphlet by Dr. Richardson; see also Meteyard's "Life of Wedgwood"); (2) his brother, Robert Waring Darwin, wrote "Principia Botanica," which reached its third edition in 1810. It is said (Meteyard's "Life of Wedgwood") that the Darwins "sprang from a lettered and intellectual race, as his (Dr. Darwin's) father was one among the earliest members of the Spalding Club."

Second Generation.—7 males, 3 females, of whom 3 males deserve notice: (1) Charles Darwin, who died at the age of only twenty-one, poisoned by a dissection-wound, but who had already achieved such distinction that his name has been frequently mentioned in biographical dictionaries. His thesis, on obtaining the gold medal of the Edinburgh University, was on the distinction between "pus" and "mucus." It was a real step forward in those early days of exact medical science, and was thought highly of at the time; (2) Robert Waring Darwin, M. D., F. R. S., a physician, and shrewd observer, of great provincial celebrity, on many grounds, who lived at Shrewsbury. He married a daughter of Wedgwood's, and was father of Charles Darwin (*see* below); (3) Sir Francis Darwin, originally a physician, but for many years living in a then secluded part of Derbyshire, surrounded by animal oddities; half-wild pigs ran about the woods, tamed snakes frequented the house, and the like.

Third Generation.—8 males, 14 females, of whom 3 males may be mentioned; but illustriously among them—(1) Charles Darwin, F. R. S., "the Aristotle of our days," whom all scientific men reverence and love; the simple grandeur of whose conclusions is as remarkable as the magnitude and multifariousness of their foundation. There is much ability in many individuals in this generation who bear the name of Darwin, and it has been strongly directed to natural history in the case of (2) a son of Sir Francis Darwin, a frequent writer, under a well-known *nom de plume*, on sporting matters. Among those who do not bear that name (being children of the daughters of Dr. Erasmus Darwin) I mention (3) myself,[1] with all humility, as falling technically within the limits of the group of scientific men under discussion, on the ground of former geographical work, and having had much to do in the administration of various scientific societies.

Fourth Generation.—Includes very few individuals who have reached mature manhood; among these are

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[1] Captain Douglas Galton, F. R. S., distinguished for official ity in many high posts, and now Director of Public Works, is d maternally, not from the Darwin, but from the Strutt has produced noted mechanicians.

(1) George Darwin, second wrangler at Cambridge, author of an important article on "Restrictions to Liberty of Marriage;" (2) Captain Leonard Darwin, R. A., who was second in the competition of his year for Woolwich, and now engaged on the Transit of Venus Expedition; (3) Henry Parker, Fellow of University College, Oxford, classical scholar and chemist.

Dawson-Turner.—This family is characterized by great intellectual activity and much artistic taste.

First Generation.—Dawson Turner, F. R. S., botanist, scholar, antiquary; a man of unwearied activity in collecting and compiling, and an encourager of work in others. One of his two uncles was the Rev. Joseph Turner, senior wrangler in 1768, and much distinguished by the personal friendship of Mr. Pitt. Among his ten male first-cousins on the paternal side were the late Lord-Justice Turner and his accomplished brothers.

Second Generation.—2 males and 6 females. The latter were all remarkable for their energy, accomplishments and the large share they took in the literary labor of their father and husbands, which was not confined to transcribing. Three were accomplished artists, one a musician, another well versed in Greek.

Third Generation.—Of those above the age of thirty there are 5 males and 3 females, of whom 4 males deserve mention: (1) Dr. Joseph Hooker, President of the Royal Society, very eminent botanist, director of Kew

Gardens, and formerly Thibetan traveler, and naturalist to an antarctic expedition; his father was Sir William Hooker, F. R. S., also one of the first botanists of his day, and director of Kew Gardens; (2) Francis Palgrave, editor of the "Golden Treasury," scholar and art critic; (3) Gifford Palgrave, Orientalist, Arabian explorer, and author of one of the most remarkable works of travel ever written; (4) R. H. Inglis Palgrave, statistician. (The father of the last three was Sir Francis Palgrave, historian.)

HARCOURT.—Scholastic success, with much love for science.

First Generation.—The Rev. Vernon Harcourt, Archbishop of York; a man of polished intellect and social gifts.

Second Generation.—10 males and 3 females, of whom 4 males deserve notice: (1) The Rev. W. Vernon Harcourt, F. R. S., chemist, the first president and one of the founders of the British Association at a time when science was partly ridiculed and partly denounced. He was the chief framer of its elaborate constitution, which is, I believe, a solitary instance of the invention of a complex administrative machinery which worked perfectly from the first, and has continued working, [illegible] unchanged, for nearly half a century. It has [illegible] del upon which many other societies have [illegible] es. (2) Egerton; and (3) Edward

Vernon Harcourt, both double-firsts at Oxford; and (4) Granville Vernon Harcourt, who died when an undergraduate at Oxford, having gained the Latin university prize.

Third Generation.—10 males and 13 females, of whom 2 males deserve mention: (1) Sir William Vernon Harcourt, M. P., lately solicitor-general, professor of international law at Cambridge, well known as a political writer under the name "Historicus;" (2) Augustus G. Vernon Harcourt, F. R. S., a distinguished chemist, Lee's reader in chemistry at Oxford.

Hill.—The characteristics of this family are, active interest in social improvement, power of organization, mechanical aptitude, and general sterling worth. Its type in the second generation seems to have been unusually pure.

First Generation.—Thomas Wright Hill, descended from stanch Independents, and married to a wife of equal vigor and fortitude, who came from a family noted for mechanical aptitude, which she transmitted to her descendants. He rose by his own exertions, and (aged forty) established a school, much spoken of at the time, on an entirely new principle of management, at Hazelwood, near Birmingham. The boys were taken into administrative coöperation; they regulated their own discipline, and the things they learned were of the most varied kind. Some men of high note were cated there, and, among these, at least one of the scientific men on my list. He gave much attention to mental calculation, and even on his death-bed (aged eighty-eight) invented and successfully applied a new method for determining for any year the date of Easter. Also known for his analysis of articulate sounds and phonography. (Short biographical notice in Annual Report of the Royal Astronomical Society, February 13, 1852.)

Second Generation consisted of 5 males and 2 females.—All 5 males had strong points of resemblance and deserve notice. (1) Sir Rowland Hill, K. C. B. and F. R. S., originator and organizer of the system of penny postage, which is an influence of the first order of magnitude in modern civilization. He was noted in youth for powers of mental calculation, and in some points was superior even to Zerah Colburn and George Bidder; thus he could mentally extract to the nearest integer the cube root of any number not exceeding two thousand millions. First inventor (1835) of rotatory printing, the method which, with slight changes of detail, is still in use for newspapers. Rewarded by three separate grants, viz., in 1846 by a public testimonial of the value of £13,360, in 1864 by the award from the Treasury of his full salary of £2,000 a year on his retirement, and in the same year by a parliamentary grant of £20,000. (2) Matthew Davenport Hill, Q. C., late Recorder of Birmingham; law reformer of note, especially in reference to dealings with the criminal class, substituting promptitude, certainty, and strictness, for delay, uncertainty, and severity (*see Law Magazine*, July, 1872); (3) Edwin Hill, superintendent of the stamp department; first inventor of the envelope folding-machine, since improved by Mr. De la Rue. He completely remodeled the stamping machinery at Somerset House; was most highly commended for these improvements in each of the first three reports of the Commissioners of Inland Revenue, and again by a minute on his retirement, referring to his "eminent and exceptional service." He, like his brother, was a standard writer on dealings with criminals; also on currency. (4) Arthur, head-master of Bruce Castle school, where he fully developed the principles first laid down by his father; (5) Frederick Hill, formerly inspector of prisons, then assistant-secretary of the Post-Office. A great and thorough reformer of the prisons under his observation, aiming to fit prisoners for honest life on their release. Concurrently, he contributed numerous memoirs on social improvements generally.

Third Generation.—14 males and 17 females, among many of whom the family characteristics continue well marked. Thus (1) Dr. Berkeley Hill, and (2) Miss Emily Clark of Adelaide, Australia, are both actively engaged in work connected with pauper children.

LATROBE.—A family characterized by its religious bent and musical and literary tastes, joined to a love of enterprise.

First Generation.—Benjamin Latrobe, a convert to the Moravians, of which estimable sect he was a patriarch and a mainstay (Aikin's "History of Manchester").

Second Generation.—3 males, 0 females; 2 at least of whom deserve notice: (1) Christian Ignatius Latrobe, author of the well-known collection of sacred music; (2) Benjamin Latrobe, architect and engineer in America.

Third Generation.—7 males, 2 females, of whom 2 deserve especial notice: (1) Charles Joseph Latrobe, Governor of Victoria at the time of the gold discoveries; author of a once extremely popular book on Switzerland, called the "Alpenstock," which was the precursor of Murray's hand-books and more generally diffused knowledge. Many others of this generation, who bear the Latrobe name, are gifted with the family characteristics. (2) John Frederick Bateman, F. R. S., distinguished engineer.

Fourth Generation—(still young)—includes Colonel Osman Latrobe, who was chief of General Lee's staff in America at an early age.

PLAYFAIR.—Among the characteristics of this family is an interest in various branches of science joined to a capacity for official work and public action.

First Generation.—Rev. Dr. Playfair, principal of the University of St. Andrews, author of a work on geography.

Second Generation.—4 males and 3 females, of whom 3 males deserve notice: (1) George Playfair, M. D., chief inspector-general of hospitals in Bengal; he was the head of his profession in India, and author of various medical memoirs; (2) Colonel Sir Hugh Lyon Playfair, who on his retirement from service pursued a life of incessant activity in public improvement (numerous biographical notices were written of him soon after his death); (3) Colonel William Playfair, whose memory still lives in India as one of the most accomplished amateur actors.

There were two cousins in this generation, the one a very distinguished man, Prof. Playfair, the celebrated mathematician, and author of the "Huttonian Theory;" the other was Mr. Playfair, an architect of much eminence, to whom many of the principal public buildings in Edinburgh are due.

Third Generation.—21 males and 20 females, of whom 2 males deserve especial notice: (1) The Right Hon. Lyon Playfair, M. P., F. R. S., formerly professor of chemistry, long engaged in scientific administration of various kinds, and postmaster-general at the close of the late administration; (2) Colonel R. L. Playfair, R. A., the well-known consul-general of Algiers, and naturalist. A third brother is a professor at King's College.

ROSCOE.—The type of this family is strongly marked; it has been characterized by much cultivation, refinement, and poetical taste.

First Generation.—William Roscoe, author of "Lorenzo di Medici," "Leo X.," etc. The above-mentioned characteristics were strongly marked in him. (Life by his son, Memoirs by Hartley Coleridge in "Northern Worthies," and "Sketches" by Washington Irving.)

Second Generation.—7 males and 3 females, of whom 4 males and 2 females deserve notice: (1) Thomas Roscoe, editor of Lanzi's "History of Painting," and author of many other works; (2) Henry Roscoe, author of a standard book on the "Law of Evidence," of "British Lawyers," and of the Life of his father; (3) and (4), both decidedly gifted, and authors of poems of merit; (1) Jane Elizabeth Roscoe, a woman of superior mind, intensely interested in public affairs, writer of some poems; (2) Mary Anne Roscoe, authoress of poems of merit.

Third Generation.—17 males, 16 females, of whom 3 males and 1 female deserve notice: (1) William Caldwell Roscoe, poet and critic (memoirs and collected works by R. H. Hutton); (2) Henry Enfield Roscoe, F. R. S., professor, eminent chemist; (3) William Stanley Jevons, F. R. S., professor, author of the "Coal Ques- ," and of various works on logic and political ny: (1) Margaret Roscoe, afterward Mrs. Sand- ist.

Strachey.—An old family, small in numbers, but of a marked and persistent type. Among its characteristics are, an active interest in public matters and an administrative aptitude.

There have been men of eminence in generations previous to those mentioned below.

First Generation.—Sir Henry Strachey, under-secretary of state, and otherwise employed in high official posts in India, America, and England; real negotiator of Peace of Versailles (Stanhope's "History of England"); received medal of Society of Arts for having introduced indigo into Florida.

Second Generation.—3 males, 1 female, of whom 2 males deserve notice: (1) Sir Henry Strachey, Indian judge, called by James Mill, in his "History of India," "the wisest of the Company's servants;" "aided much in the organization of the Indian judicial administration; (2) Edward Strachey, author of reports of acknowledged weight on Indian judicial subjects (Fifth Report).

Third Generation.—6 males and 1 female, of whom 3 males deserve notice: (1) Sir John Strachey, eminent in all branches of civil administration in India; (2) Henry Strachey, Thibetan explorer, gold medallist of the Royal Geographical Society; (3) Major-General Richard Strachey, R. E., F. R. S., active administrator of Indian engineering-work; physical geographer.

Taylors of Ongar.—Numerous members of family have shown a curious combination of restless literary talent, artistic taste, evangelical disposition, and mechanical aptitudes. There is an interesting work published upon it, called "The Family Pen," by the Rev. Isaac Taylor, 1867 (*see* below in the "fourth generation"), which contains a list of ninety publications by ten different members of the family, up to that time; and there have been more publications, and at least one new writer, since.

First Generation.—Isaac Taylor came to London with an artist's ambition, and ended by being a reputable engraver. He acted for many years as secretary to the Incorporated Society of Artists of Great Britain, which was the forerunner of the Royal Academy. All the family characteristics were strongly marked in him.

Second Generation consisted of 3 males, all of whom deserve notice: (1) Charles Taylor, a learned recluse, editor of Calmet's Bible; (2) Rev. Isaac Taylor, author of "Scenes in Europe," etc., educated as an engraver, and far surpassing his father in ability. He married Ann Martyn, a woman of reputed genius, authoress of the "Family Mansion," and the numerous able members of the Taylor family for the two next generations sprung, with one exception, from this fortunate union; (3) Josiah Taylor, eminent publisher of architectural works; he made a large fortune.

Third Generation.—Descendants of Isaac Taylor and rtyn, 3 males and 3 females, of whom 2 males and 2 females deserve notice: (1) Isaac Taylor, author of "Natural History of Enthusiasm;" (2) Jeffreys Taylor, author of "Ralph Richards," "Young Islanders," etc.; (1) and (2), Ann and Jane Taylor, joint authors of "Original Poems" (Ann married the Rev. Joseph Gilbert). In this same generation is ranked the Rev. Howard Hinton, a leading Baptist minister, who was a son of one of the sisters in the previous generation, and is father of a well-known aurist.

Fourth Generation.—6 males and 9 females now living, and some few others who are deceased; of these, 5 males and 1 female deserve special notice: (1) Rev. Isaac Taylor, author of "Words and Places," of "The Family Pen," and of "Etruscan Researches;" (2) Josiah Gilbert, author of "The Dolomite Mountains;" (3) Joseph Gilbert, F. R. S., eminent for his chemical and physiological researches in their relation to agriculture (the paternal race of Gilbert had also a marked type); (4) Thomas Martyn Herbert, Independent minister, scholar, and writer; (5) Edward Gilbert Herbert, of the Chancery bar, who died young of diphtheria; (1) Helen Taylor, authoress of "Sabbath Bells."

WEDGWOOD.—This family is curious for the sporadic character of its ability, as shown by the number of its members in rather distant relationships who have become distinguished. The Wedgwoods must originally have been of a pure type, because the name was prevalent in the village where the great potter was born, and the bearers of it were largely interrelated, and followed the same craft. He himself married a Wedgwood, who was a third-cousin, and both his father and grandfather were potters. (Meteyard's "Life.")

First Generation.—Josiah Wedgwood, F. R. S., "Father of British Pottery," whose once abundant works now fetch fabulous prices.

Second Generation.—3 sons and 4 daughters; 1 son deserves notice, viz., Thomas Wedgewood, who died young. His abilities were great; he was an ardent experimentalist, and has some claim to rank as the first person who ever made a photograph. (*See* p. 6.)

Third Generation, including descendants from the sisters of Josiah Wedgwood, contains: (1) Hensleigh Wedgwood (English Dictionary and "Origin of Language"); (2) Charles Darwin, F. R. S. (*see* under Darwin); (3) Sir Henry Holland, Bart., M. D., F. R. S., who died subsequently to my having begun this inquiry; (4) S. H. Parkes, M. D., F. R. S., Professor of Hygiene to the Army Medical School.

Fourth Generation.—(*See* under Darwin.)

STATISTICAL RESULTS.

t us now look at the near relations of the scientific
a purely statistical point of view, combining
quoted with the rest, and calculate the pro-

portion of them who have achieved distinction. It appears from my returns, which are rather troublesome to deal with, owing to incompleteness of information, that 120 scientific men have certainly not more than 250 brothers, 460 uncles, and 1,200 male cousins who reach adult life. They have somewhat *less* than 120 fathers and 240 grandfathers, because the list contains brothers and cousins. I will take two groups: (1) grandfathers and uncles, both paternal and maternal, say about 660 persons; (2) brothers and male cousins on both sides, 1,450 persons. On the supposition, which is somewhat in excess of the fact, that I am dealing with complete information concerning the families of 120 scientific men:

I find in the first group of 660 persons: (1) Jeremy Bentham, a great leader of thought and founder of a school of philosophy; (2) Wedgwood, the founder of a national industry and art; (3) Compton, the inventor of a machine for cotton manufacture, which gave a timely impetus to that great national industry; (4) Maskelyne, an astronomer-royal; (5) Playfair, the scientific head of a Scotch university; (6) William Smith, founder of British geology; (7) Harcourt, the lawgiver and first president of the British Association; (8) Pemberton Milnes, who refused both a secretaryship of state and a peerage; (9) Latrobe, who was to the very worthy sect of the Moravians much what Barclay was to th Quakers, that is to say, not its founder, but a great sup port to it; (10 and 11) two archbishops, Harcourt o

York and Brodrick of Cashel; (12) Erasmus Darwin, poet and philosopher of high repute in his day; (13) Isaac Taylor, author of "Natural History of Enthusiasm," etc. I will stop here, though it would be easy to extend the list considerably, if I took a slightly lower level of celebrity for my limit.

Every one of these 13 men, when he died, was, or would have been, if he had not previously outlived his reputation, the subject of numerous obituary notices, and his death an event of sufficient public interest to warrant his being reckoned as an "eminent man." I formerly calculated, and have since seen no reason to doubt my conclusions, that the annual obituary of the United Kingdom does not include more than 50 men who are eminent in that sense. Therefore this small band of 660 individuals contains almost one-fourth as much eminence as is *annually* produced by the United Kingdom. A different criterion of eminence may be found in the number of celebrated men reared in the universities, whither a large proportion of the brightest youths of the nation find their way. I examined the list of honors at Cambridge in the ten years 1820–'29 inclusive, and also the four years 1842–'45, of which I happen to have some personal knowledge, whence it appeared to me that, on the average, 660 Cambridge udents do not produce more than 3 men whose general nence is of equal rank to that of the 13 men in the andfathers and uncles under consideration. A more exact test, and the best of which I can think, is to examine into the fate of the boys at large schools. It is not difficult to learn the productiveness of each school as regards eminence, because there are annual gatherings, to which former school-boys who have won distinction are generally invited and not unfrequently come. As men begin to distinguish themselves at thirty-five, and may be supposed willing to attend on such occasions till seventy, the notabilities invited to be present at school gatherings represent the product of, say, thirty-five years. I feel sure that 660 middle-class boys do not turn out more than a fraction of one eminent man, though they may turn out many who do well in life and earn fortunes and local repute.

The second of the groups consists, as already mentioned, of brothers and male cousins, making a total of about 1,450 men. I will examine the achievements of these, solely in respect to high university success, partly because several of the cousins are too young to have had time fully to distinguish themselves otherwise. Let us limit ourselves to the following names (the list would be lengthened if we took a lower level): Cambridge: (1) Alderson, both first classic and senior wrangler, that is, first mathematician of his year at Cambridge; (2) Woodhouse, senior wrangler; (3) Main, senior wrangler; (4) Humphrey, senior classic; (5) Scott, joint senior classic. Oxford: here the method of examination affords no means of ascertaining who is absolutel the first of his year, since the men are grouped alphabetically in classes, and not according to their order of merit in those classes. The names I will select are those of men who were in the first class and have subsequently distinguished themselves, viz.: (6) Moberly, head master of Winchester, now Bishop of Salisbury; (7) Francis Palgrave, critic; (8) Hon. George Brodrick, first class both in classics and history, well known as an influential though anonymous writer. It is a remarkable fact or coincidence, that 5 men out of a group of 1,450, or say 1 out of every 300, should be first of his year in the single University of Cambridge, either in mathematics or in classics. This is about the proportion that exists among the men who actually *go* to Cambridge, and these, as before mentioned, are no chance selections, but include a large part of the annual pick of the intellectual flower of the whole nation. Moreover, these distinguished brothers and cousins of scientific men are themselves interrelated; the two senior wranglers, Alderson and Woodhouse, being first cousins, and the two classics, Scott and Brodrick, being first cousins also; both families being, in other respects, rich in ability.

We may otherwise appreciate the influence of heredity, as distinguished from that of tradition and education, by observing the similarity of disposition that sometimes prevails among numerous scattered branches he same family. The two following extracts from the replies I have received, are illustrations of what I mean:

(1) "My numerous relatives, though unknown to fame, are mostly characterized by great breadth of thought and rare independence of action." [These characteristics seem clearly traced by the writer to a great-grandparent who immigrated from Germany]; (2) "Counting third cousins, I have scores and scores of relatives, and scarcely an *unsteady* person among them."

I have numerous returns, in which the writer analyzes his own nature, and confidently ascribes different parts of it to different ancestors. One correspondent has ingeniously written out his natural characteristics in red, blue, and black inks, according to their origin—a method by which its anatomy is displayed at a glance.

My data afford an approximate estimate of the ratio, according to which effective ability (hereditary gifts *plus* education *plus* opportunity) is distributed throughout the different degrees of kinship. They state—(1) the number of kinsmen in the several near degrees; (2) the number of those among them who were in any sense public men; and (3) the number of those who, not being publicly known, had nevertheless considerable reputation among their friends. It is therefore only requisite (after some previous revision) to add the returns together, and to compare the number of distinguished kinsmen in the various degrees with the total number of kinsmen in those degrees, to obtain resu whose *ratio to one another* is the one we are in search of. These conclusions are not materially vitiated by the fact that different correspondents may have different estimates of what constitutes distinction, so long as each writer is consistent to his own scale. I have tried the figures in many ways—without any revision at all, with moderate revision, and with careful sifting, and I find the proportions to come out much the same in every case. In comparing these with previous results, obtained from an analysis of men of much higher general eminence ("Hereditary Genius," p. 317), I find the falling off in ability from the central figure, the hero of the family, to be less rapid as the distance of the kinship increases. There is, however, one group in that book, consisting of divines, whose general eminence is not so great as the rest, and which also resembles the scientific men in the family distribution of ability. My former figures for 100 divines gave 22 notable fathers, 42 brothers, 28 grandfathers, and 42 uncles; my present results for 100 scientific men are 28, 36, 20, and 40 respectively.

As regards the relative influence of the paternal and maternal lines, I find close equality. My method of comparison is by setting off paternal grandfathers and paternal uncles against maternal grandfathers and maternal uncles, no other near degree of kinship being ailable for the purpose. My results for 100 scientific are: paternal grandfathers, public characters, 10;

of high private reputation, 3; paternal uncles, 13 and 8; making a total on the paternal side of 34. On the other hand, the maternal grandfathers are 11 and 4; maternal uncles, 15 and 7; making a total on the maternal side of 37.[1]

I leave to another chapter some remarks about the relative value of maternal and paternal educational influences on scientific men.

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[1] In "Hereditary Genius," p. 196, having fewer cases of scientific men to deal with, I extended my inquiries to nephews and grandsons, and in a second table even to great-grandparents, great-grandsons, and other equally remote degrees, but this latter was confessedly of little value.

CHAPTER II.

QUALITIES.

Energy—Size of Head—Health—Perseverance—Practical Business Habits—Memory—Independence of Character—Mechanical Aptitude—Religious Bias—Truthfulness.

In this chapter I will speak of the qualities which the returns specify as most conspicuous in scientific men, and I shall endeavor to make them tell their own tale by quoting anonymous extracts from their communications. Some of these qualities are common to all men who succeed in life, others—such as the love for science—are more or less special to scientific men. We will begin with the general qualities, with the view of obtaining as exact an idea as may be of the degree in which they are present in the leaders of science of the present day, neither exaggerating nor under-estimating.

ENERGY.

When energy, or the secretion of nervous force, is small, the powers of the man are overtasked by his daily duties, his health gives way, and he is soon weeded out of existence by the process of natural selection; when moderate, it just suffices for the duties and ordinary amusements of his life: he lives, as it were, up to his income, and has nothing to spare. When it is large, he has a surplus to get rid of, or direct, according to his tastes. It may break out in some illegitimate way, or he may utilize it, perhaps in the pursuit of science. It will be seen that the leading scientific men are generally endowed with great energy; many of the most successful among them have labored as earnest amateurs in extra-professional hours, working far into the night. They have climbed the long and steep ascent from the lower to the upper ranks of life; they have learned where the opportunities of learning were few; they have built up fortunes by perseverance and intelligence, and at the same time have distinguished themselves as original investigators in non-remunerative branches of science. There are other scientific men who possess what is sometimes called quiet energy; their vital engine is powerful, but the steam is rarely turned fully on. Again, there are others who have fine intellects, without much energy; but these latter classes are quite in the minority. The typical man of science has been at full work from boyhood to old age, and has exuberant spirits and love of adventure in his short holidays, when the engine of his life runs free—temporarily detached from its laborious tasks.

We must be on our guard against estimating a man's energy too strictly by the work he accomplishes, because it makes great difference whether he loves his work or not. A man with no interest is rapidly fagged. Prisoners are well nourished and cared for, but they cannot perform the task of an ill-fed and ill-housed laborer. Whenever they are forced to do more than their usual small amount they show all the symptoms of being overtasked, and sicken. An army in retreat suffers in every way, while one in the advance, being full of hope, may perform prodigious feats.

In the following extracts I insert every thing that seems deserving of mention as regards the energy of either parent. It will be observed how strong is the tendency for this primary quality to be transmitted hereditarily.

Speaking generally of these and all other extracts printed in this book, I should give the following explanation:

Whenever any thing is interpolated by me it is put in square brackets [ ]. All proper names are replaced by dots, because I do not wish to administer to the love of gossip. It is indeed impossible to prevent intimate friends from sometimes guessing the name of the author, but I have taken care that nothing is inserted which
cause annoyance. I have taken some trifling edito-
ties, such as occasionally working the words of
into the answer, when the latter was too

curt to explain itself; and in a few cases the third person has been turned into the first, for the sake of uniformity.

Extracts from Returns.

MUCH ABOVE THE AVERAGE—FORTY-TWO CASES.

1. "Traveling almost continually from 1846 up to the present time. Restless. All life accustomed to extremely rough travel; often months without house or tent. *Of mind*—restless.

"*Father*—Very energetic; restless. In old age traveled considerably. Mentally restless. *Mother*—Quiet and delicate."

2. "When young, and to the age of thirty or more, worked habitually till two and three A. M., often all night. Traveled much in various climates. Much endurance of fatigue and hard living—[an excellent mountaineer]. *Of mind*—[has risen to the highest position in his branch of science, and conducts an enormous correspondence on a variety of technical and scientific subjects].

"*Father*—Very considerable energy both in body and mind. *Mother*—Below the average in bodily energy, but remarkably active mentally."

3. "When fishing or shooting (my only occupation during the holidays) I am the whole day on my legs.

Of mind—In thirteen years I examined and named some 40,000 examples, described about 7,000 species, wrote some 6,000 pages of printed matter, carrying on at the same time a great deal of correspondence.

"*Father*—I cannot say. *Mother*—Is active the whole day. At the age of sixty-three she took sole charge of my child, then but a few weeks old, nursing it for three years, night and day. Energy of mind equal to that of her body."

4. "Remarkable energy and activity of body, and power of enduring fatigue and going without food. Extremely fond of and an adept at all field sports. Abstemious. *Of mind*—Vigorous pursuit of scientific experiments and investigations, of investment and management of money, business transactions, etc.

"*Father*—Active in field sports; has ridden sixty miles before dinner. Abstemious. Energetic in mind. *Mother*—Much energy, as shown by activity and power of enduring fatigue. Great physical courage and presence of mind in danger."

5. "Remarkable for athletic exercises when at Cambridge. In early life encountered great fatigue with the army, as . . . . during the . . . . war.

"*Father*—Great activity and immense energy in the e of his profession. A man of most powerful

6. "I have been and still am a strong walker, both mountaineering and deer-stalking. I never knew what it was to be tired, but, after the hardest day, was ready to start again with six hours' sleep. Although in my sixty-seventh year, I am still an indefatigable deer-stalker."

7. "Strong when young—walked many a time fifty miles a day without fatigue, and kept up five miles an hour for three or four hours.

"*Father*—Remarkable energy of body up to the age of thirty, as shown . . . . *Of mind*—Remarkable energy from early youth to his death (brought on by accident at seventy-three), when he was as actively engaged as ever in preparing for experiments [official and of a very multifarious kind]. *Mother*—Remarkable energy of mind in assisting her father in the preparation of his lectures, and afterward her husband in his official correspondence and writings. After his death she wrote largely in magazines, and at the age of eighty-five published 'Suggestions for . . . .' [certain improvements in administration]."

8. "When under twenty, have walked twenty miles before breakfast; when about thirty-two, walked forty-five miles; dined, and danced till two in the
without fatigue. At the age of twenty-six, duri
teen days, was only three hours per night in bed

two of the nights was up all night preparing for . . . . [certain scientific work]. Fond of mountaineering."

9. "Considerable energy and power of enduring fatigue; rough traveling on small means in . . . . [partly-civilized countries]. Have rowed myself in a skiff one hundred and five miles in twenty-one hours while under-graduate at . . . .; rowed in every race during my stay at the university; rowed two years in the university crew [Oxford and Cambridge races].

"*Father*—[Many examples of his energy in his . . . . life]. *Of mind*—Considerable, compiliug and writing on a great variety of subjects, while at the same time carrying on a system of . . . . observations, and for years together. *Mother*—Energy of mind very similar to that of my father; joining nightly in . . . . observations, daily in writing or drawing . . . ."

10. "Very active in business, preferring walking to the compulsory driving; occupied fourteen or fifteen hours a day without distress; restlessness kept under conscious restraint; longing for adventurous travel, but hindered. *Of mind*—I doubt whether any one in my profession has done more work, if I may reckon the total work done in . . . ., etc., etc.; and I worked nearly as hard while a student.

"*Father*—As a young man, an active cricketer and officer. A very earnest, active man in business, heavily engaged in it from the age of eighteen. Besides, he took an active part in town affairs and the management of many associations. *Mother*—A good walker, very active in the management of her house. Although she had a very large family, and took most diligent care of them, she was always at work, collecting all manner of things, arranging, describing, corresponding, painting, copying; she was never idle."

11. "I seem to possess the same unweariedness as my father, and find myself trotting in the streets as my father used to do.

"*Father*—Was very untiring; he tells me he has ridden one hundred miles in a day. He could walk up one of the North Wales hills when nearly seventy, and used to go long distances in London, passing often from a walk into a run."

12. "In early life, occasionally working the night through. Great adroitness at games; fast runner; got the prize for fencing at . . . . On board a man-of-war in 18— . . . . did feats of agility, such as going up a rope hand-over-hand, which none of the midshipmen would attempt.

"*Father*—Great amount of quiet energy. In mind great energy and perseverance, which lasted to the end of his life. Thus he had known little Greek, but studied it when an old man for the sake of his . . . . researches; also Aramaic. *Mother*—Active house-mother."

13. "Habitually travel by night without interfering with work of any kind carried on during the day. Active habits and great power of enduring fatigue."

14. "I was in youth and early manhood bodily active, a good runner and leaper, excelling almost all my schoolfellows [the school was a large one] in both points, and a persistent walker. *In mind*—During the best fifty years of my life I went through a large amount of brain-work, and vigorously pursued the several interests indicated in the enumeration of my several occupations.

"*Father*—In bodily activity much like myself, with the addition that he was a good swimmer. *In mind*—Capable of great occasional exertion rather than of sustained effort. *Mother*—*In mind*—Very energetic within a limited range. Always showed great courage, fortitude, and equanimity. In her nursing duties, whether of young or old, was active, persevering, and remarkably successful."

15. "At the age of sixty made a tour, chiefly pedestrian, of four weeks in the Alps; ascended Cima di Jazi; crossed St.-Théodule Pass, walking sometimes thirty miles a day; aged sixty-seven, grouse-shooting and stalking. Walk six miles daily to present date. *d*—See list and dates of works and papers [an mount of work].

"*Father*—Active disposition; he let his family estate, entered largely into mercantile pursuits, and died [abroad]."

16. "When young, a very quick runner and jumper; good shot with a bow and arrow. In middle age, walked to extent of twenty-five miles a day for many months, forty miles in one day, rarely tired. *Of mind*—In early life, any amount, provided the subject was interesting."

17. "At times, great fatigue has been gone through in connection with my profession. *In mind*—A good deal of continued power of brain-work; mental fatigue is a sensation not known.

"*Father*—Very energetic. *In mind*—Remarkably so. Having been ruined in early life, he articled himself to a solicitor when he was thirty-five years of age; procured good practice, and wrote [a small technical book] on law. *Mother*—Loved to go through much fatigue. *In mind*—Very energetic; added greatly to the income of her family by her writings."

18. "Active bodily work an absolute necessity of my being; without it my epigastrium would gnaw itself into fiddle-strings. *In mind*—My scientific works must answer this question [they are very considerable].

"*Father*—Decidedly active and energetic; use go out fossil-hunting when it was too late to follow his occupation [which involved out-of-door work, lasting all day and fatiguing to the muscles]. *Mother*—Very industrious."

19. "Excelled at school and college in athletic sports, especially in long jumping (eighteen feet). *In mind*—Almost incapable of fatigue up to the age of thirty-eight. Usually engaged in literary work until long after midnight.

"*Father*—Remarkably active habits; a great reader when not engaged in drawing and writing."

20. "Excellent walker; great endurance of fatigue [facts are given]. *In mind*—Active mental effort all my life; have had abundance of active employment; am now doing duty as . . . . [numerous honorary offices of the first rank in importance and labor].

"*Father*—Energetic, with considerable endurance; good swimmer. *In mind*—He had much the same active employment as myself; he took an active share in science, politics, and in religion. *Mother*—Active habits; she had great power of doing work and carrying on business."

21. "When a boy of thirteen I walked forty-eight
one day, fifty the next, and about twenty the
n grown up, my powers were ordinary, cer-

tainly not above the average. *In mind*—Naturally indolent; disinclined to work unless with a large object. [N. B.—I insert this moderate statement because my correspondent adheres to it verbally, and gives facts and reasons which I cannot controvert; nevertheless, if energy is to be measured by work actually accomplished, and if my correspondent's work be compared with that of other men, the estimate of his energy would be prodigiously increased.]

"*Father*—When a young man he and two brothers walked sixty miles in one day. Much mental energy; ready for all purposes. When old he was astonished at the amount of work in . . . . he did when young. *Mother*—Ordinary, both bodily and mental."

22. "Has done his chief brain-work between ten P. M. and two A. M., besides all the day-labor; rests perfectly during a night railway journey.

"*Father*—Great energy, and very active; capable of enduring great fatigue."

23. "Active and energetic from infancy to eighty-four years of age. *In mind*—I must leave my works to answer this question; but I believe I have been a hard worker during the whole period of my existence. [N. B.—No doubt of it.]

"*Father*—Energetic, both in body and mind; muscular; a great reader. *Mother*—Delicate, but active and intelligent."

24. "A strong walker and oarsman; can write more rapidly than any man I ever met (thirty folios of seventy-two words, equal to 2,160 words, an hour). *In mind*—Have always worked long hours and very fast.

"*Father*—Remarkable energy and endurance, notwithstanding asthma: very hard-working as a . . . . *Mother*—Physically weak, but has had a large family; has done a great deal of original as well as of steady work."

25. "I am a hard rider with hounds, fond of mountaineering, and not easily tired.

"*Father*—An active man all his life, riding every day, and always about, although over eighty."

26. "Energy shown by much activity, and, while I had health, power of resisting fatigue. I and one other man were alone able to fetch water for a large party of officers and men utterly prostrated [other facts given in illustration of undoubted energy]. *In mind*—Shown by vigorous and long-continued work on same subject, as twenty years on . . . . and nine years on . . . .

"*Father*—Great power of endurance, although feeling much fatigue, as after consultations after long jour- s; very active; not restless. *In mind*—Habitually active, as shown in conversation with a succession during the whole day."

27. "Considerable enduring power in fulfilling any given task or duty; have dissected continually for three or four weeks eight or nine hours a day, devoting some sixteen hours to the work at critical times. *In mind*—Considerable. Wrote and superintended first edition of . . . ., giving instructions to artists regarding from 200 to 300 woodcuts, correcting press, etc., without assistance, in about seven months [all this in addition to professional work]; hard work for mind as well as body."

28. "Energetic. *In mind*—[extraordinarily so, both in administrative and in original work].

"*Father*—Energetic. Author of, I think, more than seventy scientific memoirs."

29. [Formerly great power of railway travel without fatigue. *In mind*—Active and energetic in a very high degree, as shown by the amount of his official and private work].

"*Father*—Always on horseback; traveled very constantly and rapidly. Steady in pursuit of an object. He would break in horses with great skill and patience; would learn languages with great perseverance, even after fifty years of age. *Mother*—Very energetic in . . . . inquiries."

30. "Great activity at cricket and football [illegible] age of twenty-five. Captain of . . . . eleven [illegible] years; used to row a great deal in heavy boats."

31. "I possess considerable bodily energy, and when young excelled in fencing, swimming, and the high jump. *In mind*—Have worked hard with my brain for the last thirty-five years, almost without intermission.

"*Father*—Considerable bodily energy, and a good pedestrian. *Mother*—Sluggish bodily powers, but in mind most energetic when once roused to action by a subject that interested her feelings."

32. "Sufficiently patient of ordinary fatigue, cold, and hunger, to enable me to enjoy traveling in unfrequented countries when my companions suffered much discomfort. *In mind*—Can commonly work from twelve to fourteen hours a day without any remarkable amount of exhaustion.

"*Father*—Capable of enduring fatigue."

33. [This is a case of extraordinary mental activity, as shown by evidence which I do not feel justified in quoting. It was rewarded by success, notwithstanding serious impediments in boyhood.]

"*Father*—A most energetic man; all for practical pursuits. *Mother*—An unusually strong mind, and ady love and search for knowledge."

Walked from Cambridge to London in a day. sixty-eight ascended the Piz Corvatsch, in *n mind*—[Facts evidencing considered].

"*Father*—Fond of exercise; a good walker. *Mother*—decidedly active bodily habits."

35. "I am decidedly lazy; but with due stimulus could always get through a great amount of physical work, and was rather the better for it. *In mind*—As a boy, I worked for three months all day and all night, with not more than four or five hours' sleep. When full of a subject and interested in it, I have written for seven or eight hours without interruption, and without feeling any notable fatigue."

36. "In early life as a boy I was engaged in business from twelve to fourteen hours a day, yet always found time to study and make my own instruments. Later on, my studies and scientific work were always accomplished after business-hours; and it was generally my habit to commence work after dinner, and to work in science until two, three, or four in the morning, and to begin work in business again at nine. I never thought of rest if I had any thing in hand of interest.

"*Father*—Remarkably active, and capable of sustaining an amount of bodily exertion which would have destroyed the health of most men; for example, I have known him sustain great fatigue for eighteen hours out of the twenty-four for months at a stretch. A great walker. *In mind*—Of indomitable activity; a great reader; always at work in applying discoveries in . . . .

to the arts; an untiring worker in any thing he undertook. *Mother*—Busily active; great and rapid reader of current literature—perhaps had read almost every book of interest in fiction which appeared."

37. "Used to work all day at business, and one-half or three-quarters of the night at science. From Saturday afternoons to Monday mornings would walk forty to fifty miles [in pursuit of a branch of natural history]. Could work hard at business all day (and a very anxious business), and at evening and night would work hard at [two branches of science]. Found a wonderful relief in science.

"*Father*—Energetic in traveling; great energy in business."

38. "For several years was engaged in full medical practice, and at the same time was a lecturer on . . . . and engaged in investigations on . . . . for which the royal medal was awarded by the Royal Society.

"*Father* and *Mother*—Both of active habits."

39. "In professional life I have often been up three successive nights without distress, but did not like a fourth, if it came. Consider *that* my limit. *In mind*—Wrote . . . . [a considerable work] between 11 P. M.
2 A. M., after professional hours. All the time that
voted to science has been stolen from strictly
ngagements, but more often from myself."

40. "Considerable power in earlier days of enduring mental fatigue and of taking up without difficulty a considerable range of subjects. Example: I was for a little while, at the age of seventeen to twenty, employed in teaching, and I contrived in my scanty intervals of leisure to read a very large quantity of Greek and Latin, and to become, without any external assistance, a very fair mathematician [my correspondent occupies a high official position, in which considerable mathematical knowledge is essential]. I learned also Italian at this time."

41. "I should say considerable, judging by the number of things I have been able to learn and to do since adult age."

42. "I think considerable, in mind. Have commonly had it said of me that it was wonderful how I got through so much work.

"*Father*—Was well known as a hard worker. *Mother*—A great reader; taught herself Greek and Hebrew, and learned German in later life, to read Luther and other theological writers in the original. A great student of theology."

CASES OF ENERGY BELOW THE AVERAGE—TWO CASES.

1. "No remarkable energy of body. *In mind*—Never capable of a large *amount* of brain-work; for

years have regarded myself as defective in brain-power. [The actual performance of this correspondent is considerable, and of a very high order.]

"*Father*—In early life fond of athletic sports, and an enthusiastic sportsman. Energy of mind very remarkable, shown in early university and professional life and all subsequent occupations. He wrote a large number of publications on subjects of . . . . and . . . . controversy. *Mother*—Energy of mind remarkable; zeal in pursuit of interests, excessive."

2. "Constitutionally languid, with a strong wish for greater energy and more power of enduring fatigue. *In mind*—Energetic as far as health permits. Much occupied professionally, but, when well, capable of vigorously following up the science of . . . . in leisure hours.

"*Father*—Energetic in body as far as his health allowed; in mind, very energetic. His brain-work from an early age was very large in amount, and he was vigorous and sanguine about any thing he undertook. *Mother*—Very languid; incapable of any bodily exertion. Very little energy of mind; too languid to take much interest in any thing beyond her own family."

SIZE OF HEAD.

may mention that energy appears to be correlated allness of head, a fact which is well illustrated here, although the average circumference of head among the scientific men is great. Energy is also, as we have seen, strongly marked among them; but it is much more strongly marked among those who have small heads. I have ninety-nine returns, many of which I have verified myself, using the hat-maker's whalebone hoop, and measuring inside the hats. It appears that the average circumference of an English gentleman's head is 22¼ to 22½ inches. Now, I have only thirteen cases under 22 inches, but eight cases of 24 inches or upward. The general scientific position of the small-headed (who are mostly slender, but not necessarily short) and large-headed men seems equally good; but the fact is conspicuous that, out of the thirteen of the former, there are only two or three who have not remarkable energy; and out of the eight of the latter there is only one who has. A combination of great energy and great intellectual capacity is the most effective of all conditions; but, like the combination of swiftness and strength in muscular powers, it is very rare.

HEALTH.

The excellence of the health of the men in my list is remarkable, considering that the majority are of middle and many of advanced ages. One-quarter of them state that they have excellent or very good health, a second quarter have good or fair, a third have had good health since they attained manhood, and only one-quarter make complaints or reservations. Here are two examples of excellent health in which some details are given: 1. "Only absent from professional duties two days in thirty years; only two headaches in my life." The next is from a correspondent who is between seventy and eighty years of age. 2. "Never ill for more than two or three days except with neuralgia; no surgical operations except inoculation, drawing of one tooth, and cutting of corns."[1]

I may add a characteristic biographical extract from the *Times*, October 31, 1873, relating to the late Sir Henry Holland, who was on my list: "Certain it is, as all who have fallen in with him by sea or land will attest, that he might be seen in all climates, in the arctic regions or the tropics, on the prairies or the pyramids, in precisely the same attire—the black dress-coat in which he hurried from house to house in Mayfair. Yet he never had a serious illness till his last. There was not a day, probably not an hour, when he could not boast of the *mens sana in corpore sano;* and, without headache or heartache, he attained the extraordinary age of eighty-six."

It is positively startling to observe in these returns the strong hereditary character of good and indifferent constitutions. I have classified the entries, each entry giving the health of the scientific man, of his father and of his mother respectively, and find as follows: First, a long row of such terms as these: "Excellent; excellent; excellent;" or "Good; good; good;" then comes another row in which some ailment is specified by the scientific man as affecting himself, and as having also affected one or other of his parents. Examples: 1. "Excellent, but hay-fever; father, excellent, but severe hay-fever." 2. "Good in early life, subject to headache; father, good, subject to headache." 3. "Delicate in early life, one lung seriously affected; mother delicate and phthisical." I can find only two cases, neither very strongly marked, in which both parents are described as unhealthy, although marriages between such persons are not infrequent. The returns seem to show that the issue of these marriages are barely capable of pushing their way to the front ranks of life. All statistical data concur in proving that healthy persons are far more likely than others to have healthy progeny; and this truth cannot be too often illustrated, until it has taken such hold of the popular mind that considerations of health and energy shall be of recognized importance in questions of marriage, as much so as the probabilities of rank and fortune.

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[1] I read this at my lecture at the Royal Institution. It was n the pen of the geologist, Prof. Phillips; a few days afterward, illed by a fall down-stairs at Oxford!

I may mention, as a fact that corroborates my belief in the exceptionally good *physique* of scientific men, that I find the average height of those who have sent me returns, to be half an inch above that of their fathers.

PERSEVERANCE.

Steady perseverance is a third quality on which great stress is laid; but this might have been anticipated, and it is unnecessary to quote many instances. Here are a few:

1. "I have, probably beyond the average, steadiness of determination, even when the subject is distasteful." 2. "Steadiness decidedly marked." 3. "Determination never to leave unaccomplished a matter once taken in hand." 4. "Great continuity and steadiness." 5. "Steady and intense perseverance." 6. "Very persevering, not discouraged by defeat." 7. "Determination to succeed when possible; my motto being, 'Whatever thy hand findeth to do, do it with all thy might,' for 'the night soon cometh when no man can work.'" 8. "I do all things at a white heat, but never tire of the pursuit." 9. "Continuous pursuit of certain studies from an early age." 10. "Steadiness and perseverance in the pursuit of an object is my most distinctly-marked peculiarity." 11. "The most prominent are perseverance and industry. A willing mind and determination to persevere is, in my opinion, the most direct road to success; we must, however, exercise a sound judgment in the selection of subjects on which to exercise our thoughts."

I do not think it necessary to quote the instances ere either parent is also spoken of as being remarkably persevering; these may be taken for granted. I find that the father is referred to in strong terms eight times, and the mother only twice.

As a set-off to the above, Impulsiveness is not confessed to by a single physicist, chemist, or mechanician. It is equally absent in their parents, with the exception of the mother of one of them. Among the remaining men of science, I only find five cases, but these are mostly combined with some tenacity of purpose, and they are all inherited.

PRACTICAL BUSINESS HABITS.

Some prevalence of practical business habits might also have been anticipated, but they prove to be much more common than I had expected. Among those who have sent me returns, I count no less than seventeen who are active heads of great commercial undertakings. There are also ten medical men in the highest rank of practice, and eighteen others who fill or have filled important official posts. Here are some answers to my special inquiries:

1. A most eminent biologist wrote as follows, in reply to the inquiry whether he had any special tastes bearing on scientific success, in addition to those for his own line of investigation: "I have no special talent except for business, as evinced by keeping accounts, being regular in correspondence, and investing money

very well." It is clear that method and order are essential to the man who hopes to deal successfully with masses of details.

2. "I believe I may say that my organ of order is highly developed. Of my collection of some seven thousand birds' skins, every one is always in its place, ticketed with name, etc., all by my own hand. I spend much time, perhaps too much, in putting things straight."

3. "I believe I am reckoned a good chairman at public meetings, and I always find that administrative and other work gravitates toward my hands."

4. "My professional life is strictly methodical; every working-day is still mapped out into hours, half-hours, and quarters."

Fully one-half of those who state that they possess business habits in a decided degree accredit one or both of their parents with the same faculty.

Only two of my correspondents speak of being deficient in business capacities. Both these are physicists.

The following quotation may with propriety be inserted here, although the first-named quality, independence, is the subject of a future chapter: "I attribute the knowledge I have acquired, and any success I had, chiefly to three qualities, all of which I believe I inherited. First, independence of judgment which prompted me to learn for myself what I wanted to know. Secondly, earnestness, determination, and perseverance in acquiring such knowledge, often under difficulties, and in the face of routine business occupation; and thirdly, a business-like, practical, logical way of looking at things, which enabled me to direct attention to the important and relevant, neglecting the unimportant and irrelevant points in what I had to study and do."

MEMORY.

Memory is very variable in power and character; perhaps no other quality is more so. It is an important ingredient in that aggregate of faculties which form general scientific ability, as is shown by the fact that about one-quarter of the men on my list possess it in a high degree, but it is not an essential one, because it is defective in about one case in fourteen. A good memory is of greater importance to the young student who has much to learn, than to the advanced philosopher who has chiefly to reflect, and who knows where to refer for information. Memory is usually defective in persons of small ability, but not invariably so; even among idiots it may be sharp. There are two cases of this recorded in the autobiography of the late Mrs. Somerville (p. 92). One cannot but suspect some exaggeration in the statements, and feel regret that the cases were not full inquired into, both as regards the precise power of memory, and the degree of development of the other faculties. She says of the first idiot: "He never failed to go to kirk, and on returning home could repeat the sermon word for word, saying, 'Here the minister coughed, here he stopped to blow his nose.'" She then speaks of "another idiot who knew the Bible so perfectly that, if you asked him where such a verse was to be found, he could tell without hesitation and repeat the chapter."

I have sorted such of the replies as are of interest into the following groups: (1) Good verbal memory, as for prose and poetry, 6 cases; (2) good memory for facts and figures, 9 cases; (3) good memory for form, 6 cases; (4) good memory for names in natural history, 4 cases; (5) good memory, no details, 5 cases; (6) fitful and peculiar memory, 6 cases; (7) bad memory, 7 cases. Total number of noteworthy cases, 43. I have not included in the above a few instances in which the scientific man has described his own memory simply as "good," nor others in which he has made no remark, except that one of his parents had very good memory. The hereditary character of this quality is abundantly illustrated.

Good Verbal Memory, as for Prose and Poetry.

Very great, both for facts and words; I could r days often retain poetry after two perusals, and, once learned, it was seldom forgotten. I have seldom met a quicker or more retentive memory in any one."

2. "After reading over a lecture or speech of an hour's duration, three times, can recollect nearly the words as written for 8 or 10 days." [I am informed verbally by this correspondent, that he is obliged to abstain from writing out his addresses, etc., beforehand, otherwise he has found the memory of what he wrote to be so strong and exacting as to make it difficult to him to deviate from it and accommodate his language to the current temper of his audience.]

"*Mother*—Excellent memory."

3. "Considerable, both verbal and objective; great facility in quotations; familiarity with large collections of coins and specimens.

"*Father* and *Mother*—Both good memories."

4. "In childhood, all the Psalms, old version; much old English poetry; afterward, nearly the whole Latin grammar (Eton), Virgil, Ovid, Lucan; still later, considerable parts of the Iliad, Odyssey, etc., could be, and partly can [still] be, repeated *ex memoriâ;* zoölogical, botanical, mineralogical, and paleontological names in abundance."

5. "My memory was very good. I remember
boy to have read Schiller's 'Thirty Years' Wa

could afterward without effort say pages of the work by heart."

6. "At school I used to learn in a single evening a hundred lines of Virgil, and repeat them correctly in the morning.

"*Father*—Very good."

Good Memory for Facts and Figures.

1. "Next to no verbal memory, but good for facts small or great which will fit into any chain of reasoning."

2. "Of moderate verbal memory, but strongly retentive of facts and figures so far as they are related to any subject on or in which I was engaged.

"*Father*—Memory very retentive, but not systematic. He had a great amount of information, but had not great acquirements; his familiarity with Scripture was, however, remarkable. *Mother*—Very retentive for small facts and figures."

3. "My memory of things learned early in life (as dates, rules, examples of grammar, etc.) very retentive, but of all isolated facts of subsequent occurrence, as the birthdays of my children, and the dates of events of my own life, I am singularly destitute of retentive power. On the other hand, of whatever is linked by rational association with any subject in which I take an interest, memory is very good.

"*Father*—The power of his memory was shown by the great range of his acquirements; he had greater power of remembering isolated facts than I have."

4. "I should say far above the average. I can now refer to note-books of thirty years past and select a special observation. In other words, it is a capital working memory. I never tried to learn pages of poetry, etc.; in this I should probably have failed."

5. "Memory exceedingly strong and retentive, especially of dates, figures, and events.

"*Father* and *Mother*—Both had good memories."

6. "Great memory for figures; can get up pages for examination before committees, and dismiss them from memory afterward. Strong recollection of scenery."

7. "Very retentive memory, especially of acts, circumstances, and individuals."

8. "Never kept a diary; clear remembrance of events in childhood with their dates in every year from the age of six onward. Solve problems better out-of-doors than in the study. Can forget useless knowledge, such as formulæ, rules, gossip, etc., very fast."

9. "Bad memory for names and dates, but good as regards facts or circumstances; principles in pl[illegible] science are clearly retained.

“*Father*—Excellent memory for historical events, including dates and names in ancient and modern history. *Mother*—Moderately good.”

Good Memory for Form.

1. “Memory most treacherous except in certain respects. Vivid and generally very accurate as to places and visual images. As to thousands and perhaps tens of thousands of specimens and plants, can remember the exact spot where each was gathered. As to a multitude of facts that should have interested me, my memory is a blank and the original impression revived with difficulty, if at all. . . . Very retentive and accurate as to the *sequence* of impressions from early childhood onward.

“*Father*—Remarkably retentive memory; quoted long passages from classical authors not seen for a very long time previously. Shortly before his death, at seventy-three, recited a long passage from ‘Gibbon,’ not read for fifty years before. *Mother*—Memory not reliable generally, but clinging strongly to special scenes and events.”

2. “I recognize most of the animal forms which I have previously examined, but I forget easily the details of their structure, also their systematic names (specific, not generic). Likewise I have a good memory for faces, but not for names of persons; could never remember al dates.”

3. "Great power of remembering forms and points of objective interest; none of numbers or abstract arguments. Languages, poetry, etc., soon lost if not kept up."

4. "Strong local memory especially of scenery."

5. "Very good memory for ideas and general notions, also of persons and places seen; verbal memory not at all good. *Mother*—Good memory."

6. "Great memory for faces and objects once seen."

7. "A good memory for faces, for locality, for things, for events, for scientific facts; but not particularly good for figures or quantities, except in all necessary routine, as in prescribing and in subjects of lecture. Never failed to recall what I desired, in my lectures.

"*Father*—An excellent memory; was a very first-rate whist-player. *Mother*—An excellent memory; played a capital game at whist."

Good Memory for Names in Natural History.

The power of recollecting a multitude of grotesque and barbarous names, which all naturalists must possess to a considerable degree, and which seems so extraordinary to persons who are not naturalists, is hardly alluded to in these returns. It would appear that our most eminent naturalists are not very specially gifted amo fellow-workers in this respect. Here are a few cases of a rather good memory of the kind:

1. "Memory strong up to the age of thirty-eight; still good and capable of recognizing and naming probably between two and three thousand species of animals and plants, including fossil forms.

"*Father*—Remarkable; capable of accurately repeating from memory the substance of speeches delivered at clerical and other meetings."

2. "Retentive of botanical names; rather deficient in other respects, especially as to persons."

3. "Retentive for nomenclature, but not for numbers or history."

4. ". . . . during practitional life I have gone over the foraminiferæ and remember all their names."

Good Memory, no Particulars given.

1. "Very remarkable retentiveness of memory.

"*Father*—Good. *Mother*—Very good, full of anecdote."

2. "Very good memory as far as my eighty-fifth birthday."

3. "Very good.
Father—Good."

4. "Very retentive, but not exactly accurate."

5. "Retentive memory for what was of interest, and very accurate."

"*Father*—Retentive."

6. "Very good as a boy and young man."

Fitful and Peculiar Memory.

1. "Occasionally remarkable, but very fitful. I have occasionally been able to repeat pages after once or twice reading; at other times it is below the average. A power of eliminating and retaining the salient points of what I read, if it interests me, but very bad memory for facts and details."

2. "Although I can speak for an hour or two from a few notes, I could not repeat correctly a few sentences from memory.

"*Father*—Remarkable for good verbal memory; could repeat pages of poetry and speeches, without mistake—a striking contrast to my own memory."

3. "My father and myself have memories of the same character; treacherous in matters of business, and very retentive of scraps of verse read over and learned long ago. When my father was to have met me, a little boy returning from school at the end of the h

he would forget all about it. My engagements sometimes suffer . . . . [from similar forgetfulness]."

4. "Memory very retentive in regard to incidents and events, but could never learn by rote except with great effort. Often surprise my patients by recollection of their symptoms, but am often at a loss to connect their names with their faces.

"*Father*—Memory remarkably retentive, especially as to the various events of his life and time."

5. "Memory very bad for dates and for learning by rote, but [extraordinarily] good in retaining a general or vague recollection of many facts.

"*Father*—Wonderful memory for dates; in old age he told a person, reading aloud to him a book only once read in youth, the passages which were coming; he knew the birthdays and those of the deaths, etc., of all his friends and acquaintances."

6. "A peculiar memory; bad for names of persons, plants, places, etc.; good for subjects connected with others; not bad for numbers.

"*Father*—A most marvelously retentive memory; he could relate minute details of historical occurrences, names of actors in politics, almost all he had ever read e was a great reader), and was in consequence a most y companion. *Mother*—Not very good."

Bad Memory.

1. [A physicist informs me that his memory is unable to retain even the commonest constants in habitual use, and that the selection of his special line of investigation was governed by his sense of this disability.]

2. "Bad memory; from boyhood incapable of learning school-tasks by heart, though retaining a knowledge of principles and methods."

3. "I have a very poor memory; I was once a whole fortnight in recovering the name of . . . ., but I got it at last. I consider that all attempts at making me learn poetry, and in particular Latin poetry [at school], were gross mistakes; I was never benefited in the least. Reasoning was my forte, and I could never do any thing by rote."

4. "A bad memory, especially for names."

5. "Not possessed of a retentive memory either in small matters or large ones, except in those in which I take a *special* interest."

6. "I was always slow at learning."

7. "Memory not retentive; very much under the influence of association and suggestion.

"*Father*—Memory very retentive as to principles, facts, and incidents; not much so as to names of persons and objects. *Mother*—Not retentive."

INDEPENDENCE OF CHARACTER.

We now come to the qualities that are of especial service to scientific men; those already mentioned, of energy, health, steadiness of purpose, business habits and memory, being of general utility. The first of these is independence of character. Fifty of my correspondents show that they possess it in excess, and in only two is it below par. Here are a few examples:

1. "Left, at the age of twelve [that is, ran away from], a school where I had received injustice from the master." 2. "Opinions in almost all respects opposed to those in which I was educated." 3. "I have always taken my own independent line. My heresy prevented my advancement." 4. "Preference for whatever is not the fashion, not popular, not rich, not very able to help itself, yet with qualities unworthily overlooked or unjustly oppressed."

The home atmosphere which the scientific men breathed in their youth was generally saturated with the spirit of independence. Examples:

1. "My father was extremely independent, in some respects more so than I am. He never altered the fashion of his dress; he never took off his hat to any one in his life, and never addressed any one as Esq." 2. "My
her was a Liberal when Liberalism (then styled Jaco-
n) was highly obnoxious, an early denouncer of
nd advocate of religious liberty, a free-trader

when the world was protectionist, and an opponent of unrighteous war when war was most popular. He was for mitigating our criminal code when hanging was regarded as the sheet-anchor, and, in a word, was politically and socially a very independent spirit." 3. "My father [an exceedingly humane and courageous man, who was a master in the Royal Navy] would never, unless compelled, attend the flogging of seamen, a punishment mercilessly and unsparingly administered in his days (1800–1815)." 4. "It was marked in my father; he held Jacobite opinions, when it was not very safe to hold them." 5. "Maintenance by my father of religious and political creeds at a time when these creeds were unpopular and often disqualifying."

In confirmation of the assertion that the scientific men were usually brought up in families characterized by independence of disposition, I would refer to the strange variety of small and unfashionable religious sects to which they or their parents belonged. We all know that Dalton, the discoverer of the atomic theory, and Dr. Young, of the undulatory theory of light, were both Quakers, and that Faraday was a Sandemanian. So I find in these returns numerous cases of Quaker pedigree; and I know of one man, not as yet technically on my list, who was born a Sandemanian. There are also representatives of several other small sects, as Moravians and Bible Christians, and the Unitarians are numerous. It will be understood that the object of saying this is not to throw light on the religious tendencies of the scientific men (concerning which I shall have almost immediately to speak), because so off-hand a statement would mislead, but to prove that they and their parents had the habit of doing what they preferred, without considering the fashion of the day. The man of science is thoroughly independent in character.

MECHANICAL APTITUDE.

There is a prevalent taste for mechanics among scientific men, whose peculiarity it is to be interested in things more than in persons. One would have expected to find it developed among physicists; and, as a fact, eight of them possess it in a high degree, and similarly among mechanicians and engineers, all of whom must possess it, and four of whom testify to it, but it seems just as strong among the rest. Here are instances and extracts:

Chemistry.—1. “Constructed a reflecting telescope, with 12-inch aperture.” 2. “Ground, polished, and silvered a 7-inch glass speculum, and mounted it equatorially.” *Geology.*—3. “Considerable mechanical skill.” *Biology.*—4. “Always fond of constructing; school nickname, ‘Archimedes.’ If I had followed my profession should probably have been [very successful as] an engi-[illegible].” 5. “Very fond of mechanical contrivances. In-[illegible]nd made my own toys as a child. Mechanical tastes are still largely indulged in intervals of leisure." 6. "Special love of mechanics; a good amateur cabinet-maker and blacksmith. Made lithotrites." 7. "Talent for mechanics." 8. [Was extremely ingenious in devising modes of preserving and exhibiting objects of natural history.] 9. "Strong natural inclination toward mechanism." [His present profession was accidental and against the grain.] 10 and 11. "Aptitude for mechanism." 12. "A decided turn for mechanical pursuits, both in arrangement and construction." *Statistics.*—13. "Fond of and quick in understanding machinery." 14. "I always took great interest in mechanical improvement." 15. "I often feel a positive pain in passing an object of which I do not comprehend the meaning and construction."

RELIGIOUS BIAS.

It appears that out of every ten scientific men, seven call themselves members of the Established Churches of England, Scotland, or of the now disestablished Church of Ireland, and three belong to one or more of the following sects, which I name in the order in which they are most numerously represented:

1. None whatever; 2. Established Church with qualification; 3. Unitarian; 4. Nonconformist; 5. Wesleyan; 6. Catholic; 7. Bible Christian. There is Quaker, and even some Moravian blood, but the

none who have sent me returns who still profess those creeds. The creeds of the parents are somewhat more varied than the above, and the Unitarian element is stronger.

The religious feeling of men of science is necessarily of a peculiar character. Being thoughtful men, they are probably more occupied with religious ideas than the generality of people; but, being exacting of evidence and questioners of authority, they sturdily object to much that others accept easily. But what is "religion?" It is one of the vaguest of words. Let us try to express ourselves more clearly. I think we may assume that the general tendency of scientific men is to take a "philosophic" view of life; that is, to show some disregard of the petty, transient events which chiefly absorb the attention of mean minds, and to feel most at peace when their thoughts are reposing on the larger and more enduring aspects of the moral and material world. Also, it would be easy to show that no class in the community are more active as philanthropists than scientific men. But these tendencies do not cover the meaning of the phrase, "religious bias," in its technical sense. So far as I understand that sense, it comprises three elements:

1. Great prevalence of the intuitive sentiments; so much so, that conflicting matters of observation are apt
be laid aside, out of sight and mind. The intuitive
of a supreme God, who communes with our hearts

and directs us. 2. A sense of extreme sin and weakness, as expressed by the liturgical phrases, "No power of ourselves to help ourselves," "Through the weakness of our mortal nature we can do no good thing without Thee," etc. 3. Revelation of a future life and of other matters variously interpreted by different sects, which, more or less, satisfy the intuitive sentiments.

I did not enter into these details in framing my questions, but simply asked in general terms whether or no my correspondents had a strong religious bias. The interpretation I put on the answers which are subjoined is, that religion, in the sense of the third paragraph, is not actively accepted by many of those who describe themselves as religiously inclined: they seem singularly careless of dogma, and exempt from mysterious terror. Also, considering the independence of their disposition, their energetic temperament and healthful *physique*, I should think that religion, in the sense of the second paragraph—that of feeling sinful and weak—would not express the views of many of them. Therefore I look on the intuitive sentiments, as described in the first paragraph, connected with a philosophic frame of mind and a tendency to active philanthropy, as the most likely meaning of the phrase "religious bias," when it is used without any qualification by my correspondents, especially by those who are Unitarians. In this sense, at least, there appear to be about eighteen instances of scientific men who have a decided religious bias; being, I should estimate, at the rate of two or more in every ten; but I am not able to state with certainty how many of these are religious in the sense of all the three paragraphs.

Religious Sentiments weak, accompanied with more or less Skepticism.—1. [Being compelled to attend frequent chapels at college, he, for ten years afterward, refused to enter either church or chapel.] 2. "The negative tendencies of my family may be absence of piety . . . ." 3. "Religious feeling not great." 4. "Skeptical." 5. "Not much religious bias except in a boundless admiration of Nature." 6. "I gave up common religious belief, almost independently from my own reflection." 7. "Bias toward freedom of thought in religious matters."

Intellectual Interest in Religious Topics.—1. "Entertained at an early age independent views regarding the resurrection and salvation of the heathen, which led to frequent disputes." 2. "At school I became a skeptic, and even worked out, in my own somewhat (at that time) reserved mind, a kind of idealism. I afterward had a phase of religious fervor, but worked through it." 3. "Given to theological ideas, and not reticent about them." 4. "Instinctive (or original) religious bias,
gh this may be in part due to early training. . . .
nsiderable pains in the investigation of religious
of my amusements being the collection of

a considerable theological library, with the books of which I am familiar."

Dogmatic Interest.—"I have no more doubt about the plenary inspiration of Scripture than I have about the simplest axiom in mathematics." [I class this exceptional reply under "dogmatic interest," because the remainder of the writer's brief communication hardly suggests the dependent frame of mind that is characteristic of "piety"—e. g., "Never received or asked a single favor or a single farthing for any thing I ever wrote or did."]

Religious Bias.—1. "Religious bias." 2. "Of a religious bias of thought." 3. "Religious views liberal, but strongly anti-materialistic." 4. "Early religious impressions strong, but have, on the *dogmatic* side, quite disappeared. The belief in a permanent antithesis between good and evil, irrespective of utilitarian results, has survived, with no keen sense of the need of a dogmatic basis for the belief." 5. "Much religious bias of thought from early education." 6. "I have been the more biased toward religion, in that my father and maternal grandfather lived it, and did not prate about it. I am personally only a combination of these two men in this respect. (Please . . . . take the *sense* of what I have written, and not the *words.*)" 7. "Religiou

of thought decided." 8. "Although firmly ar oughly believing in Christianity, and accepting it as the guide of my life, as far as I can understand it, being also a regular attendant of the Church of England, still I cannot admit the right of that or any other Church to teach dogmatically what truths are necessary for my salvation; and the feelings which ever cause me to resent any interference with the liberty of conscience are quite as strong in me as they were in the breast of my ancestor, when he gave up the land of his birth and property, more than three hundred years ago." [My correspondent has shown marked instances of independence of character, and is descended maternally from both Flemish and French religious refugees, and paternally from an English Nonconformist, who left his country and settled in America.] 9. "It is difficult to estimate one's own peculiarities, but I believe I may credit myself with more than the usual amount of (. . . . and) religious bias of thought. I have mixed and worked with Christians of most of the Protestant Churches." 10. "Strong religious feeling. My intention on entering . . . . was to devote myself to a missionary life in China; but my unexpected success in . . . . persuaded my friends to induce me to abandon my purpose, on the ground that I might serve God better in my new sphere at home. I yielded to their arguments with great reluctance." 11. "Intensely religious; formerly in the evangelical sense (a tract distributor, promoter of prayer-meetings, Bible-sses, etc.). Excessive distaste to novels and fictions in any shape." (*See "Indifference to Dogma,"* p. 103.) 12. "I was brought up an ordinary member of the . . . . Church, but ultimately came to the conclusion that . . . . was essentially illogical. . . . I had the happiness of seeing my mother follow me into the . . . . Church." [I regret that I am unable, with propriety, to give fuller extracts from the most interesting and instructive replies of this correspondent.]

Religious Bias, with Intellectual Skepticism.—1. "I have not cultivated independence of judgment in religious matters; I have shrunk from so doing in order to retain peace of mind and leisure for my varied studies. 2. "Much religious bias of thought, but no respect for revealed religion as a base for such a bias." 3. "Religious bias toward natural theology strong, as distinguished from dogma of any kind." 4. "I have, perhaps, a religious bias from early habits and associations, rather than from temperament; but I have always had more pleasure in sacred than in secular music, which, perhaps, shows the predominance of the emotional tendency." 5. "A profound religious tendency, capable of fanaticism, but tempered by no less profound theological skepticism."

Next, as regards the effect of dogmatic teaching, or of "creed," on research. I had expected it to have been much more deterrent and hindering than the answers warrant. The suicide of the geologist, Hugh Miller, whose brain gave way under the conflict between dogmatic creed and scientific doubt, is a terrible tale. One would have thought that the anathemas from the pulpits against most new scientific discoveries, as soon as they became capable of popular application, such as geological history, antiquity of man, and Darwinism, must have deterred many; and, as I have already shown, few of the sons of clergymen are on my list. Nevertheless, in answer to my direct inquiry, "Has the religious creed taught in your youth had a deterrent effect on the freedom of your researches?" I am met with an overpowering majority of negatives. Seven or eight say "no," justifying their assertion by various reasons, to one who says "yes," as is shown by the appended replies. These may be sorted into the four following groups:

(1) "No" deterrent effect—39 cases. (2) "None," with emphasis—12 cases. Examples: "None whatever;" "not in the least;" "not in the slightest;" "decidedly not;" "certainly not." (3) "None," with various classes of reasons why it had not—14 cases. (4) Has had a good, and not a bad effect—8 cases.

Further specimens of the first two groups "no," with or without emphasis, are needless; but I will give extracts from the remainder, divided under convenient heads.

Have no Dread of Inquiry.—1. "I do not think so. t the time when I held strongly the . . . . dogmatic system I never could apprehend any dread of the results of free inquiry." 2. "None whatever. Absolute and fearless faith in the truth." 3. "I was left free to choose my own religion, and believe that there is no real antagonism between revealed religion and the study of Nature."

Religion and Science have Different Spheres.—1. "No; it [religious creed] has no point of contact with chemistry."

Indifference to Dogma.—1. "Not in the slightest degree; but the method of science has taught me not to put any confidence in creeds or dogmatic statements of any kind." [This correspondent is the tract-distributor, etc., of (11) of those having "religious bias," in p. 100.]

Liberality of Early Religious Teaching.—1. "None. The teaching was not severe or exclusive in any degree; it was the ordinary teaching of the Church of England." 2. "My religious creed from infancy was that of freedom. I was not taught creed or dogma, and had therefore the great advantage of not having to fight my way out of darkness into light." 3. "I learned no creed in my youth." 4. "I had no religious instruction at school." 5. "No; freedom of thought was always made a part of the creed practically taught me." 6. "No religious creed was ever taught to me." 7. "None whatever. In fact, no *creed* was taught me." 8. "

religious freedom has enabled me to look every scientific question fairly in the face." 9. "There was no religious coercive education at home, notwithstanding my mother's strong personal religious bent. On the contrary, her influence was quite in the direction of free inquiry, in which she largely indulged herself. My school religious teaching had no effect that I can perceive, either on my intellect or imagination. Its chief result was to make me detest the drudgery of learning catechisms and sitting through dreary sermons."

[2, 3, 6, 7, 8, are children of Unitarian parents.]

Have early abandoned Creeds.—1. "At the age of thirteen I disbelieved, as thoroughly as I do now, the religious creed (that of the Church of England) in which I was brought up; and I had realized Berkeleyan idealism by my own road." [Compare this with the reply, 2, from a different correspondent, in p. 98 in the section "*Intellectual Interest in Religious Topics.*"] 2. "None whatever; I have long since wholly rejected religious creeds." 3. "I gave up common religious belief almost independently from my own reflection." [This quotation is repeated from the last section. The writer's reply to the question of which we are now speaking was a simple "no," and has been classified as such.]

The Religious Creed has had a Good Effect on Free-Research.—1. "None [i. e., no deterrent effect];

rather the contrary." 2. "On the contrary." 3. "Quite the reverse." 4. "I think none whatever. I have had to overcome some prejudices, but my true religious life has been cognate with my scientific one, and the former has stimulated rather than crippled the latter." 5. "Certainly not! On the contrary, it has had clearly the very best effect." 6. "Not a deterrent effect; but it acted as a guide." 7. "Never deterred; now acts as a direct stimulant, since it appears to me that the cultivation of a naturally-implanted intellectual tendency is a religious duty. . . . The most pernicious influence to which I was subjected was that arising from J. Stuart Mill. It took me a long time to work through the sensationalist, empirical philosophy, and to come out at the other side." 8. "No; but the scientific system inculcated long prevented me giving my religious feelings and aspirations full sway."

Has had some Deterrent Effect.—1. "Certainly the narrow . . . . ism of early youth made me for a long time a timid thinker." 2. "To a certain extent, yes—not in philosophical research; but I shrink from the disturbance of mind (not fear of ultimate consequences) which I know would follow diving into certain questions of the day, connected with early religious teachings." 3. "No; for some time it may have hindered me." 4 "It certainly would have had that tendency, though not that effect, if my researches had taken certain directions." 5. "Would have been so had I not fought against it." 6. "The 'Biblical faith' prevented my getting good geological views for many years, by having set my thoughts in the old grooves, and thus limited them." 7. "I think not. I emancipated myself from dogmatic trammels early in life, but not without a struggle." 8. "After about ten years' careful consideration of the facts, called by theology 'seeming contradictions of science,' I finally discarded the pentateuchal spectacles through which I had previously looked at certain phenomena. I lay to early theological teaching so much hinderance in the quest of the most precious of our possessions—truth."

TRUTHFULNESS.

A curiosity about facts is much spoken of and implied in the answers to my questions; in a few cases it is combined with a curious repugnance to works of avowed fiction. A hunger for truth is a frequent ingredient in the disposition of the abler men of every career; but in all probability it is felt most strongly and continuously by men of science. The most clearly-marked characteristic of scientific society seems to me to lie in the careful accuracy with which facts and anecdotes of all kinds are related. I have the good fortune to be acquainted with a large family circle whose curiosity about facts and practice of scrupulous and, so to speak, *artistic* truthfulness, continually excite my admi ration. It has not unfrequently happened to me to hear a remark or statement, which I had made to one of its members, alluded to by another, in which case I have been usually astonished at the precision with which it was repeated. The repetition of the statement retained the precise shade of sense that I originally intended to convey, yet it was almost always presented in a simpler and more striking form. The essentials had been truthfully adhered to; the non-essentials were pruned off and the language was improved. The rarity of a faculty like this is easily tested by the experience of the well-known game of "Russian Scandal," and has probably been impressed on most of us when we have discovered some misrepresentation of what we did or said. Truthfulness of expression adds greatly to the charm of life; it gives a grateful sense of confidence toward those who are distinguished for it, and it makes conversation more real and far more interesting. There is an exact parallel between truthfulness of expression in speech and that of delineation in drawing. In the earliest sketch it is far better to be hard in outline than inaccurate. Subsequent touching up can smooth away the hardness; but there exists no proper material to work upon when there was carelessness in the first design.

CHAPTER III.

ORIGIN OF TASTE FOR SCIENCE.

Preliminary—Extracts at length—Analysis; Innate tastes—Fortunate accidents—Indirect motives or opportunities—Professional duties—Encouragement at home—Influence and encouragement of friends—Influence and encouragement of tutors—Travel in distant parts—Unclassed residuum—Summary—Partial failures.

WHAT were the motives that first induced the men on my list to occupy themselves with science?

A question such as this may seem hard to answer, except in very general terms. Those who are but little versed in statistics may be daunted by reflecting on the infinite diversity of characters and antecedents; while those who are, will be less easily discouraged. Reiterated experience will have shown them how surely, in every case with which they have dealt, the great majority of causes, or what might be better named "preefficients," admitted of being analyzed and grouped into natural orders, leaving a minority of unclassed influences, which themselves form a class of their own, and which can be reduced indefinitely, in proportion to the minuteness with which the statistician cares to pursue his analysis. The statistics of railway accidents will serve as an example. When Captain Douglas Galton was secretary of the railway department of the Board of Trade, he succeeded in sorting their causes into the groups in which we have since been accustomed to see them printed year after year. So long as the general system of management of a railway is little changed, the same statistical ratio is maintained among them, a given proportion of accidents being due to this cause, and another to that. We may therefore estimate with some certainty the saving of life and limb, or of material of various descriptions, that will be effected when any one of these causes shall be wholly or in part removed. Similarly my aim is to group the influences which first urged the men on my list to pursue what afterward became their favorite occupation. We shall learn the relative importance of these influences, and be enabled to estimate, with greater precision than before, the value of proposed methods for making the pursuit of science more common than at present.

The returns I am about to quote are replies to the following questions: "Can you trace the origin of your interest in science in general, and in your particular branch of it? How far do your scientific tastes appear to have been innate?"

The answers were of unequal length and minuteness. From the longer ones I have extracted what was essential, and in these and in the rest I have taken a very few editorial liberties, as already mentioned.

At this stage of the inquiry it becomes advisable to separate the replies according to the branch of science pursued by those who made them. I have not kept geography separate, because there are not many geographers on my list, and those who were, admitted of being sorted under other titles. With this exception, the divisions I have adopted are much the same as those of the various sections and sub-sections of the British Association.

Some doubt may be felt as to how far the replies may be trusted. For my own part, I believe they are substantially correct, judging principally from internal evidence, and partly from having questioned different members of several families, and finding their opinions corroborative. The greatest difficulty I have had in my inquiries generally is due to reticence on the part of the writers, who say nothing when much was to be said; but even this does not affect *relative* results. Again, many men are conceited; still the forms in which conceit shows itself do not much affect those results. Thus, a too emphatic narration of early achievements does not distort their mutual proportions. If men are too proud to acknowledge their indebtedness to natural gifts, the relative value they ascribe to motives remains unchanged. I am astonished at the unconscious vanity which I have elsewhere met with when making inquiries in heredity, shown by men who, owing enormously to natural gifts, wish to accredit their own free-will with being the real cause of their success. One phase of this form of vanity is prominently illustrated by the late John Stuart Mill, in his strange and sad autobiography, who declares (p. 30) that he was rather below par in quickness, memory, and energy, and that any boy or girl of average capacity and healthy physical constitution, who was properly taught, could make as rapid progress in learning as he did himself! As regards the scientific men, I find, as I had expected, vanity to be at a minimum, and their returns to bear all the marks of a cool and careful self-analysis. My bias has always been in favor of men of science, believing them to be especially manly, honest, and truthful, and the result of this inquiry has confirmed that bias.

The influences and motives which urged the men on my list to occupy themselves with science fall under the heads given on the succeeding page. I have distinguished each head by a letter, and added to each reply the letters that seemed appropriate to its contents. The replies are subsequently analyzed according to these letters.

SIGNIFICATION OF THE LETTERS.

	Number of Instances.	
a.	59	Innate tastes (*mem:* not necessarily *hereditary*).
b.	11	Fortunate accidents. It will be noticed that these generally testify to the existence of an innate taste.
c.	19	Indirect opportunities and indirect motives.
d.	24	Professional influences to exertion.
e.	34	Encouragement at home of scientific inclinations.
f.	20	Influence and encouragement of private friends and acquaintances.
g.	13	Influence and encouragement of teachers.
h.	8	Travel in distant regions.
z.	3	Residual influences, unclassed.

EXTRACTS AT LENGTH.

PHYSICS.

(1) "My tastes are entirely innate; they date from childhood" (*a*).

(2) "As far back as I can remember, I loved Nature and desired to learn her secrets, and have spent my whole life in searching for them. While a school-boy, I taught myself botany, chemistry, etc. . . . under great difficulties. I had no teacher except a kind apothecary, whose knowledge was limited" (*a*).

(3) "From a youth I always preferred the man of marked ability to the man of action alone. Thrown for years of my professional life among men chief-

ly of the latter class, and my sympathies being more drawn toward those in the decided minority, my tastes were, I conceive, not acquired, but innate. In the early days of my professional career I gained the friendship of . . . ., of the highest professional standing, whose acquired general knowledge and love of science and observation were far beyond those of the ordinary . . . . of his time. I was both his young friend and favorite assistant for three years. He imbued me with his respect for science, and formed my character for earnestness and accuracy. . . . To some extent my tastes were determined by events after manhood; because in . . . . extending over ten years, I held positions of great responsibility [in different parts of the world]; but I consider my scientific tastes were formed in youth, that is, from sixteen to twenty-one years of age" (*a*, *f*, *h*).

(4) "From an early age I was addicted to mechanical pursuits. In the last few years of my school-days I took to chemistry. Entered . . . . college, expecting, after two or three years there, to [join a relative's] business as calico-printer, and gave especial attention to chemistry on that account. . . . I had never attended *specially* to physics until appointed professor of natural philosophy. . . . [This and subsequent similar advancement] determined me to devote myself thenceforward definitely to physics, and not to try for a chemical appointment . . . ." (*a*, *d*).

(5) "Naturally fond of mechanics and of physical science, in which all my study has taken the direction of those departments bearing on . . . ., owing to my feeling that, through the possession of special instruments for investigations in it, I could work to greater advantage; not from any natural preference for . . . . over the other departments of physical science" (*a*, *c*).

(6) "My tastes were partly natural, partly encouraged by an eminent friend . . . ., who had been honored himself by the friendship of most of the leading men of science in the early part of this century" (*a*, *f*).

(7) [Yes.] "I remember [incidents which proved an innate taste quoted at length] before I could write, [but] I believe the origin of my pursuit of physical science was when I attended the natural philosophy class at . . . . I was intended for business, but, conceiving a distaste for it, I left it, and attached myself to science" (*a*, *g*).

(8) "I cannot say, except that I had an innate wish for miscellaneous information. My interest in science arose from the chance circumstance of my choosing civil engineering as a profession, and having spare time, when studying at . . . ., which I devoted to . . . . My scientific tastes were subsequently determined by my not ving any profession, except civil engineering, which I followed" (*c*).

(9) "Ocean-voyaging in beginning of life. Solitary observing for years in an observatory, placed in a country verging on a desert, but under southern skies rich in stars unknown to the ancients, and not appreciated by the moderns" (*d*, *h*).

(10) "The origin of my interest in science is mainly due to my father's knowledge of geology, navigation, and engineering. My scientific tastes were confirmed by lectures, by . . . . and . . . . and . . . ., and especially by the encouragement of the latter" (*e*, *g*).

(11) "Primarily derived [both by inheritance and education] from my father" (*a*, *e*).

(12) "My first start was reading a child's story, called the 'Ghost,' where a philosophical elder brother cures his younger brother of superstition, by showing him experiments with phosphorus, electricity, etc. This set me on making an electrical machine with an apothecary's phial, etc. I was then about twelve years old. My grandfather had scientific tastes to some degree. My grandmother's brother . . . . was a good amateur chemist and astronomer. He was a well-known leader of musical, and, to some extent, of scientific society, at . . . ." (*a*).

(13) "A mathematical tendency, I think, led
toward . . . . inquiry, to which I have been

ever since. Professional duties and civil engineering kept up a disposition to appreciate the material constituents of the world, and led, through surveying, in the direction of physical geography. The distinct origin of my desire to place myself among scientific students was the wonderful impression produced on me by the aspect of Nature, as seen in the . . . ., combined with what I may call the accident of my having been allowed to explore a part of it in an official capacity. Having thus made rather large botanical and geological collections, I came to England with them, and, while employed in arranging and distributing them, picked up a certain rather irregular and unsystematic scientific education, in the company of . . . . and others. Forced back into professional life, special scientific inquiry has not been possible; but I have had opportunities of aiding the progress of science, which I have endeavored to make the best of" (*a*, *d*, *f*, *h*).

(14) "Largely determined by my service in north-polar and equatorial expeditions" (*d*, *h*).

(15) "I am not aware of any innate taste for science. I can only remember in boyhood the influence of the Philosophical Society of . . . ., and of a juvenile philosophical society in which I took interest. My interest in astronomy, especially, was very small indeed, l I was appointed [to the directorship of an observa- (*d*).

Mathematical Sub-section.

(16) "I always regarded mathematics as the method of obtaining the *best* shapes and dimensions of things; and this meant not only the most useful and economical, but chiefly the most harmonious and the most beautiful. . . . . I was taken to see . . . ., and so, with the help of Brewster's 'Optics' and a glazier's diamond, I worked at polarization of light, cutting crystals, tempering glass, etc. I should naturally have become an advocate by profession, with scientific proclivities, but the existence of exclusively scientific men, and in particular of . . . ., convinced my father and myself that a profession was not necessary to a useful life" (*a*, *e*, *f*).

(17) "My taste for mathematics appears innate. As a boy, I delighted in sums. I trace the origin of my interest in general science to my acquaintance with . . . ., which dates from the time when I was about fifteen years of age. I taught myself in mathematics and chemistry during my apprenticeship to a civil engineer and land-surveyor, and subsequently studied . . . . [abroad]. My scientific tastes were largely developed through my first going [to the Continent] with . . . ." (*a*, *f*).

(18) "An early taste for arithmetic, and in particular for long-division sums" (*a*).

(19) [The following is an extract from biographical notes kindly communicated to me of the late Archibald Smith :] "Yachting would give an interest to all nautical matters, and the intimacy of his father with . . . . gave a bias toward magnetism. In a letter to one of his sisters (no date, ? about 1838), he says: '. . . . told me he was going to write directions for ships, finding and allowing for the error caused by the local attraction of ships. So, for my own amusement and partly to help him, I wrote a set of instructions and gave them to him.' His mind was thus turned to the subject. I think it was natural to him to inquire into the reason of things. Fond of figures when a boy" (*a*, *b*, *c*, *f*).

(20) "My interest in mathematics began at . . . . [university], and was mainly due to the energy and encouragement of my tutor . . . .; but Prof. . . . . first inspired me with the sense of the magnificence of mathematics" (*g*).

CHEMISTRY.

(1) "Thoroughly innate. My first taste for chemistry dates from the possession of a chemical box, when I was a little boy. Whenever I had a chance of turning from other studies to natural science, I always turned. "[illegible]ed play better than all other work, and chemistry [illegible]an play" (*a*, *b*).

(2) "Perhaps wholly innate. My first notions of chemistry were picked up from books, and I got the nickname of 'experimentalizer' at school. My taste for zoology arose through friendship with . . . . My tastes were largely determined by three years' voluntary work at chemistry, under Dr. . . . ." (*a*, *f*).

(3) "I was always observing and inquiring, and this disposition was never checked nor ridiculed in my childhood. My taste for chemistry dates from the lectures I attended as a boy, and to the permission to carry on little experiments at home in a room set apart for the purpose. I was encouraged in my tastes at home. Subsequent determining events were my residing abroad, and my mother making a home for me there" (*a*, *b*, *e*).

(4) "They date from a very early period, and there was little to produce them in my early surroundings. As a small boy I was fond of reading books bearing on natural science. I was taught at home with my brothers, and was partially self-taught also. We had always the example of industry, and were encouraged to think for ourselves. I first studied chemistry at . . . . College" (*a*, *e*).

(5) "From an early age I had an innate tas
branches of natural science. As a boy, I m
collections of dried plants, minerals, beetles, t

stuffed birds, etc. At . . . . I studied without regard to future profession for two years, and only took up chemistry as a special study on my third year's residence there" (*a*, *c*).

(6) "I cannot trace the origin. I began to study chemistry at the age of eighteen, and pursued it at such times as my duties in . . . . gave me leisure, and without any instructor. The obtaining of correct and accurate results in chemical analysis gave me great satisfaction" (*c*).

(7) "Scarcely innate. I ascribe the origin of my scientific interests chiefly to being sent as a pupil to an eminent man of science, Prof. . . . . Subsequently I was a good deal abstracted from scientific pursuits by an early and lasting friendship with . . . ., who directed my thoughts to public work" (*g*).

(8) "I watched, at school, the building of a steam-engine at a factory, and completely got up the whole engine. This gave my mind a start. . . . My father gave me 'Henry's Chemistry;' that, and afterward 'Turner's Chemistry,' were more interesting to me than any books of fiction. . . . I believe at one time I read little else but 'Turner's Chemistry' and books of poetry n whatever holiday I had. . . . I owe to my mother a l's curiosity and afterward a man's reverence for sci- truth. I cannot tell if my scientific tastes were

innate. The university, inviting me to fill the . . . . chair, gave my work its bent. . . ." (*d*, *e*).

(9) "I can trace my interest in chemistry to reading by accident a book upon it" (*b*).

(10) "I did nothing, even *quasi*-scientific, till after leaving college; nothing serious till the age of twenty-three. My pursuit of chemistry is entirely due to circumstances occurring after manhood, and in direct opposition to family influences" (*z*).

(11) "To the opportunity afforded for study of science at . . . . My tastes received no encouragement whatever from relations, my mother excepted" (*e*, *z*).

GEOLOGY.

(1) "Decidedly innate as regards coins and fossils. My father and an aunt collected coins and geological specimens, and I have both coins and specimens which have been in my possession since I was nine years old. Subsequently my pursuits were influenced to some extent by the discoveries in . . . ., but at that time I had already a considerable collection" (*a*, *c*, *e*).

(2) "A natural taste for observing and gene
developed by noticing the fossiliferous rocks w
pened to occur in the neighborhood of the schoo

was. Afterward the surgeon to whom I was articled, who had an observant mind, fostered my tastes" (*a*, *b*, *f*).

(3) "A natural taste. My interest in science began very early, originating in a love of experiment, at first in chemistry. . . . The ultimate direction of my scientific tastes dates after the completion of my regular education" (*a*, *c*).

(4) "I believe I may say innate, to a very considerable extent, not remembering that any definite steps were taken to inculcate science. I was indebted in a high degree to collections made by my father and mother, in . . . ., and to early familiarity with charts of those seas, and conversations on matters pertaining thereto; afterward, to going to Germany and finding in the mining officers a body of men receiving a regular scientific education; lastly, to a great extent by going for a winter to . . . . [in Germany], and by conversations with . . . . and . . . ." (*a*, *e*, *f*).

(5) "I was always fond of natural history; collected plants, insects, and birds, at [school] and fossils at [college], where . . . .'s lectures attracted me to geology, and subsequently, by the acquaintance of Prof. . . . ., to the particular branch [of it which I have pursued]" (*a*, *f*, *g*).

(6) "As well as I can recollect, they were innate. I [illegible]r, as a boy of six, seeing a spring in Lavender

Hill; not being satisfied at the explanation, and determining to work it out for myself. I believe that I should have devoted myself to chemistry and physics, but that I was started, as a youth of nineteen, to travel ten months out of the twelve on business, and so continued for twenty years. This led to my visiting all Great Britain, and to great opportunities for geologizing, and determined me to that study. I worked hard at business all day (a very anxious business), and at evening and night would work hard at chemistry and geology. I found a wonderful relief in science" (*a*, *c*).

(7) "I believe the desire for information and habits of observation to be in a great measure innate. They were first developed by a little elementary teaching in physics and chemistry, at school, between the ages of seven and thirteen. I worked alone at science at home, from the age of eleven years, where I was encouraged by the example of an elder brother. Subsequently, my pursuits were much influenced by being thrown, at the age of nineteen, on my own judgment and resources. I founded a mining colony in the backwoods of . . . ., and had to carry it out with several thousand people, quite alone" (*a*, *e*, *h*).

(8) ". . . . I was always apt to observe stones closely with regard to their qualities" [but the [illegible] tific taste for geology was not developed till aft [illegible] hood] (*z*).

BIOLOGY.

Zoological Sub-section.

(1) [Yes.] "Inherited from my father's family, who have generally been attached to natural history [especially botany; most remarkable examples are given]. My scientific tastes were largely determined by being appointed . . . ." (*a*, *d*, *e*).

(2) "Certainly innate. . . . Strongly confirmed and directed by the voyage in the . . . ." (*a*, *h*).

(3) "Love of observation and natural history innate; [I had them] as early as I can remember. My grandfather was very fond of natural history, and a [more distant] relative has written an excellent fauna of . . . . The help of Mr. . . . has aided me immensely, but not, I think, altered my tendency" (*a*, *e*, *f*).

(4) "Homology innate, and derived from my mother. I trace the origin of my interest in science decidedly to my mother's observations in our childhood rambles, on the plants and animals we saw. She told me that crabs were 'sea-spiders,' and periwinkles (*Littorinæ*) 'sea-snails.' I feel sure she had never read 'De Maillet!' . . . ." (*a*, *e*).

(5) "I believe I inherited my general taste for scien-
rsuits from my grandmother; but my choosing
special investigation resulted from a positive

fascination which the very obscurity of the subject exerted upon my mind. It was perhaps a mere desire to unravel the marvelous. My scientific tastes were largely promoted by the attractive teaching of [. . . . various professors]" (*a*, *c*, *e*, *g*).

(6) "Thoroughly innate. I had no regular instruction, and can think of no event which especially helped to develop it. Bones and shells were attractive to me before I could consider them with any apparent profit, and books of natural history were my delight. I had a fair zoological collection by the time I was fifteen. My father had no scientific knowledge; nevertheless, he encouraged me in all my tastes, giving me money freely for books and specimens, against the advice of friends; but he was indulgent generally, and not in the scientific direction only" (*a*, *e*).

(7) "Innate, as far as a love of Nature and of the observation of natural phenomena. I trace the origin of my interest in science to the love of truth and of mental cultivation in my father, and his encouragement of this love in his children. I do not think it was largely determined by events after manhood" (*a*, *e*).

(8) "I should say innate. I caught at all scraps of lessons for self-improvement. My soon-develop
thusiasm must have been derived from my
family. As to whether they were largely devel

events occurring after manhood, I think not. All I can say is, that neither profession nor marriage nor sickness has been able to affect them" (*a*, *e*).

(9) "I cannot recollect the time when I was not fond of animals, and of knowing all I could learn about them. Living in the country, I had abundant opportunities for indulging my taste, though, of course, I was not allowed to keep half the number of 'pets' I should have liked. The example of my father and elder brothers, who were all pretty firm to field-sports, was also followed by me, and from field-sports to field natural history is but a step. I obtained, by a piece of sheer good luck, the traveling fellowship of . . . .; it was tenable for nine years, and its income was sufficient to keep me during that time without being obliged to enter any profession. Though circumstances subsequently interfered with my using this assistance to the most advantage, in gratifying my taste for natural history, it was enormously furthered thereby" (*a*, *b*, *c*, *e*).

(10) "My partiality for the natural history sciences was initiated partly by my selection of medicine as a profession, and perhaps even more that, during the period of my apprenticeship, I was much under the influence of a remarkable man . . . ., a most accomplished
ralist and of singularly independent judgment. . . .
ee years I spent every Sunday morning with him.

During this time he was constantly stimulating me (a willing follower) to work in his department of natural science, and at the same time ever inculcating a spirit of scientific skepticism" (*d*, *f*).

(11) "To love of birds, their study, their dissection. I remember trying to find out in the structure of the oviduct the cause of color and markings in the different eggs. I discovered hairs sticking in the cuckoo's stomach, arranged in a spiral manner, before I knew that John Hunter had described the same. Then I took to drawing skulls and skeletons, and my fate was sealed. That I inherited a strong love of Nature is certain, from my father, who was devoted to horticulture, and very fond of birds and of landscape scenery; but I cannot trace any direct tendencies or work on the part of any member of my family, except my brother. I feel that I must have had a taste for science, independently of external circumstances. At the age of seventeen or eighteen, I had dissected every new kind of bird that I met with. Later opportunities were entirely made by myself, or perhaps, rather, taken advantage of by myself" (*a*, *e*).

(12) "My love of natural history (so common in boys) showed itself in collecting insects, shells, and birds' eggs, and delighting in reading such bo
Stanley on "Birds," White's "Selborne," "W

etc., at a very early age (eight years or before), and, being rather encouraged than checked, continued to grow till it developed into a fondness for anatomical pursuits generally, which was never abandoned. My taste [for science] was entirely innate; no [other] member of the family nor early friend or acquaintance had any special taste for any of the natural history sciences. Two brothers, of nearly the same age, and with precisely the same surroundings, though joining occasionally in some of the above-mentioned boyish pursuits, never pursued them with real interest, and soon entirely gave them up" (*a*, *e*).

(13) "As a boy, I had no taste for natural history, but a passion for mechanical contrivances, physics, and chemistry. I earnestly desired to be an engineer, but the fact that I had a . . . . [near relative] a medical man led to my being apprenticed to him, and I took to physiology and anatomy, as the engineering side of my profession. [The inclinations above mentioned were] altogether innate, and, so far as I know, not hereditary, neither of my parents nor any of the family showing any trace of the like tendencies. My appointment to the surveying-ship . . . . made me a comparative anatomist, by affording opportunities for the investigation of the structure of the lower animals. My appointment to . . . . forced me to paleontology" (*a*, *c*, *d*, *h*).

) "My school nickname was 'Archimedes;' I was always fond of construction. If I had followed my own bent, I should probably have been [successful as] an engineer. My turn for scientific inquiry led me in early life to systematize and generalize the knowledge of others. Latterly I have felt more interest in original investigations" (*a*, *c*).

(15) "I was in a general atmosphere of scientific thinking and discipline. My taste for biology began with keeping insects; for chemistry and physics, by being led to try experiments. Largely inherited from my father. I have made my circumstances more than they have made me" (*a*, *c*, *e*).

(16) "My father's example influenced me so early that I have no means of judging, but I doubt much their innate character. Their origin was due primarily, beyond all probability of doubt, to my father's influence and example. They were not influenced by subsequent events, but the tastes once planted rather determined the events. My medical profession caused me to suspend my scientific pursuits for some years; but the accidental perusal of . . . . brought me back again to the study of the . . . ., and all the rest followed in due time" (*b*, *e*).

(17) "They appear to have been inherited. My interest in science arose from the example of my father, and the fact of my being for a year the assistant and

close companion of Prof. . . . . . of . . . ., at whose side I visited the poor in the lanes of . . . ., day and night. First began to work and concentrate energies to one branch at the age of twenty-one, when appointed . . . ." (*a*, *d*, *e*, *g*).

(18) "They have been, I believe, nearly in an equal degree the mixed result of a natural bias and education, and were determined by professional study, when a love of scientific knowledge for its own sake first took possession of my mind" (*a*, *d*).

(19) "How far innate, and how far acquired and developed from my early youth, I cannot say. My love for animals of all kinds was very strong, and to gratify it I overcame every obstacle put in my way at home, when I was a boy. I trace the origin of my interest in science to the earliest impressions of my childhood, all of which, so far as I recollect them, are connected with my father and the various animals he brought me as pets. They were not largely determined by events after manhood. I should have been an observer of animal life under any conditions under which I might have lived" (*a*, *e*).

(20) "I cannot trace the origin of my interest in geology. I believe it to have been innate. I began col-[illegible] birds and studying them before I went to school, [illegible]t any inducement. I was always told by my [illegible] my scientific pursuits would stand in my

way, but adhered to them notwithstanding. They were not at all determined by events occurring after I reached manhood; they simply increased as I grew older" (*a*).

(21) "I perceive no evidence of their being innate [? hereditary], unless I derived any tendency from my mother, who was at one time much with her great-uncle [. . . . the founder of one of our great industries], and greatly interested in his pursuits. She worked a good deal at chemistry, and was well acquainted with many of the processes in pottery. I belonged to an industrious family, and saw every one working. The attraction I have for chemistry (which is a strong one, only my profession has never allowed me to follow it very closely) arose from being sent to work, at the age of fifteen, in a chemical laboratory" (*e*).

(22) "I do not consider them innate, but induced by the following circumstances: When I was at school (between thirteen and fifteen years of age), a lady, an old friend of my mother, gave me a few British shells, with their names, and a copy of 'Turton's Conchological Dictionary.' I thenceforth diligently collected British shells, and afterward extended my researches" (*b*).

(23) "To my father's example (in science); to the profession of medicine (in physiology, anatomy, and . . . .). It was my interest in my profession
at scientific subjects, while young and while w

practice. The example of many men whom I knew when young proved a great stimulus and incentive" (*c*, *d*, *f*).

(24) "Not at all innate. I can trace it distinctly to my intercourse with certain professors . . . .; subsequently, to my desire to investigate certain scientific questions bearing on medicine; and later, to my intercourse with . . . . and . . . ." (*c*, *d*, *f*, *g*).

BIOLOGY.

Botanical Sub-section.

(1) "My scientific tastes were inborn" [and strongly hereditary] (*a*).

(2) "As far as the word applies in any case, I should say decidedly innate. Excepting such influence as a little encouragement at home, I am unable to trace any external stimulus. At the age of six I was given Joyce's 'Scientific Dialogues,' which I soon mastered, then other books; before the age of eight I commenced making star maps; at twelve to thirteen years of age I made some geological sections with tolerable correctness; and so on. It [then] seemed as if any accident and the love of new
tas were enough to lead me from one branch of sci-
o another" (*a*).

ys fond of plants" (*a*).

(4) "Was always fond of objective and experimental knowledge. I date my first efforts of any consequence from an early intimacy with Prof. . . . ., whose pupil and assistant I was. I had a fondness for science before, but the necessity for accurate and rigid observation then first dawned upon me. Subsequent events were going to . . . . [abroad], and appointments in . . . . [a foreign country, where I was much detained in-doors, that] compelled me to take to the microscope and study of the lower orders of plants and animals, many of which I could grow in my own room" (*a*, *c*, *g*).

(5) "As a youth, I followed, of my own free-will, mineralogy, chemistry, anatomy, and mechanics, but chiefly chemistry. My tastes were certainly not hereditary. They were directed to botany purely through accidental circumstances [which led to a prolonged residence in an imperfectly civilized country]. I examined its plants, then wholly unknown to Europeans, but was at that time wholly ignorant of the very elements of botany. Was subsequently encouraged by . . . . [eminent botanists of the day]; went to and from England and made extensive collections. My wife actively assisted me in my botanical and other scientific pursuits, and to her advice and assistance I owe much of my success in life" (*a*, *f*, *h*).

(6) "The love for botany was instilled i [illegible] very early youth by my father. We lived i [illegible]

of . . . . [a very eminent geologist], in the vicinity of . . . ., and I often took walks to those hills and collected plants. I also cultivated plants in our garden. A taste for natural science, especially botany, seems to have been innate. The companionship of . . . . incited me to prosecute botany with vigor. I was one of his best pupils, and traveled over a great part of . . . . with him" (*e*, *g*).

(7) [A posthumous account.] "He appears to have been attached to natural history all his life through, but never took up botany to any extent till the professorship was vacant. [There is some conflict of testimony here.] I think his scientific tastes were innate. I have excellent drawings of insects made by him as a school-boy; also, he made a model of a caterpillar; tried a little chemistry; made lace with bobbins of his own contriving. . . . It was said, 'Nothing escapes that boy's eyes'" (*a*, *d*).

(8) "To my father's encouragement of a natural inclination" (*a*, *e*).

(9) "I cannot trace the origin of my interest in any particular branch of science further than that as far as regards . . . . botany, I was thrown into the society of a gentleman who took much interest in it. My scientific
stes originated, as a matter of fact, after leaving . . . .
university]" (*f*).

(10) "Not innate. I trace the origin of my botanical tastes to leisure; to the accidental receipt of De Candolle's 'Flore française,' while resident in that country; and to encouragement from my mother. They were determined afterward by independence (considering my absence of ambition to rise in the world), and by friendship and encouragement from . . . ., the four greatest British botanists of the day" (*b*, *e*, *f*).

BIOLOGY.

Medical Sub-section.

(1) "Innate in a great degree. I trace the origin of my interest in science (1) to my mother's mental activity and love of collecting and arranging, and my father's constant encouragement of my pursuits; (2) to the friendship of [three eminent botanists], by whom I was chiefly induced to study botany; (3) to my profession, the choice of which was in some measure determined by my taste for collecting and studying" (*a*, *d*, *e*, *f*).

(2) "I selected the medical profession because it was that of my father. This choice led me to scientific pursuits, for which I had no previous predilection, as I had no opportunities that way. I conclude the tastes were innate, as they certainly showed themselves the moment the opportunity for developing them occurred, namely,

at the commencement of my professional studies, aged seventeen" (a, d).

(3) "Not at all especially innate. I could have taken to any other subject quite as well, so far as I know. I trace the origin of my interest in science to the knowledge that I must do my best in it to earn a livelihood and to please my parents. I did not follow my own branch from any special liking—indeed, I disliked it; but it was necessary to follow some branch. The connection with a hospital and medical school in . . . . . has been an inducement to continue work, and all my life I have worked pretty steadily" (d).

(4) "I cannot perceive that they were innate. Possibly my tastes were due to retentiveness of memory as to objects and facts, and a strong impression that good surgery is a great fact. Subsequently, by the approval of teachers, when between the ages of eighteen and twenty, having been selected chief assistant to the most popular teacher of anatomy of his day, and also to a professor of surgery" (c, g).

(5) "Had an interest excited in philosophical inquiries by my father's acute observations in all such topics" (e).

(6) "I cannot say that I had naturally a turn for any pursuit in particular. My addiction to medicine was

purely the result of accident. I never gave a thought to physic as a subject of study until I was twenty-seven years old" (*d*).

(7) "Accidentally [directed] to medicine by associating with a medical friend in a superficial study of botany" (*c*, *d*).

STATISTICS.

(1) "Certainly my scientific tastes appear to me to have been, so to say, innate" (*a*).

(2) "My interest in science was due to my having been officially employed in the early part of [my career, in a very important statistical inquiry]" (*d*).

(3) "Innate, I think. I inherit many mental peculiarities and talents from my paternal grandfather, among which is a love of figures and tabulation; none from my father. I cannot [otherwise] trace the origin of my interest in science, nor were my tastes largely determined by events after manhood" (*a*).

(4) "I should be much inclined to think there was an innate tendency, but that the tastes were developed by a good and for the most part suitable education. When at my first school, aged ten and a half to twelve years, the head-master gave very clear occasi

in moral and economical subjects. I can remember vividly to the present day the impression which those lessons made upon me. As I am not aware that the other boys in the class were equally impressed, I think I must have had an innate interest in those subjects; but the lessons probably increased the interest very much" (*a*, *b*, *g*).

(5) "I cannot distinguish between what I may have derived from nature and what I may have acquired from intercourse with my father and certain of his friends. When I was eleven years old, my father gave a series of lectures on electricity, mechanics, astronomy, and pneumatics, to all of which, but especially to the last, I paid delighted attention. I presently began to construct apparatus for myself. Subsequently practice in teaching led me to seek for knowledge. Intercourse with men of higher attainments became a great spur; my turn for . . . . was favored by my opportunities as an early member of the . . . . Society" (*a*, *e*, *f*).

(6) "Prof. . . . .'s lectures on geology were the origin of my interest in that science; the work of the . . . . Statistical Society in educational inquiries influenced my taste for statistical science; frequent attend- ce at meetings of the British Association encouraged ific tastes" (*d*, *g*).

MECHANICAL SCIENCE.

(1) "If any tastes be innate, mine were; they date from beyond my recollection. They were not determined by events after manhood, but, I think, the reverse; they were discouraged in every way" (*a*).

(2) "Decidedly innate. The science of . . . . was well taught at the University of . . . ., where I studied, between sixteen and eighteen years of age, and accidentally this became serviceable to me when employed as an engineer by . . . . The friendship of . . . . materially affected my career. My tastes were not largely developed by events occurring after manhood" (*a*, *b*, *d*, *f*).

(3) "Family tradition derived through my mother's side. My profession fell in with my natural tastes, such as sketching" (*c*, *d*, *e*).

(4) "Innate, I think, as regards certain qualities of mind, which led me, under the pressure of circumstances, to direct my attention to certain things in a certain way, namely, (1) independence of judgment; (2) earnestness of purpose; (3) a practical, clear-headed, common-sense, logical way of viewing things" (*c*, *d*).

(5) "I cannot say whether they were innate. I was always brought up in a half-scientific, half-literary atmosphere, and was a fair mathematician as a boy, as well

as a fair classic and linguist. My tastes were not determined by after-events, but my avocations were rather determined by my scientific habits" (*e*).

ANALYSIS OF REPLIES.

Having given the replies in gross, it now becomes our business to sort their contents under different heads. It would be useless, and even embarrassing, to make lengthy extracts from them; short abstracts will therefore be given, which the reader may verify whenever he pleases by the help of the reference number, printed in parentheses ( ), which is the same both here and in the original.

§ A.—INNATE TASTES.

Instances of a strong taste for science being decidedly innate. I have not included among these the whole of the cases to which an *a* has been affixed:

Physics and Mathematics.—Twelve cases out of twenty replies. (1) My tastes are entirely innate; they date from childhood. (2) As far back as I can remember, I loved Nature and desired to learn her secrets. (3) Always attracted by men of ability. (4) From an early age I was addicted to mechanical pursuits; then to chemistry. (5) Naturally fond of mechanics and physical ence. (6) My tastes were partly natural, partly encouraged. (7) I remember [incidents which proved an innate taste] before I could write. (8) I had an innate wish for miscellaneous information. (11) Primarily derived [both by inheritance and education] from my father. (16) I always regarded mathematics as the method of obtaining both the most useful and the most harmonious, etc. (17) My taste for mathematics appears innate; as a boy I delighted in sums. (18) An early taste for arithmetic, and in particular for long-division sums.

Chemistry.—Five cases out of eleven. (1) Thoroughly innate. (2) Perhaps wholly innate. (3) I was always observing and inquiring. (4) They date from a very early period, and there was little to produce them in my early surroundings. (5) From an early age I had an innate taste for all branches of science.

Geology.—At least seven out of eight cases. (1) Decidedly innate. (2) A natural taste for observing and generalizing developed. (3) A natural taste; my interest in science began very early. (4) I believe I may say innate to a very considerable extent. (5) I was always fond of natural history. (6) As well as I can recollect, they were innate. (7) I believe the desire for information and habits of observation to be in great measure innate.

Zoology.—Eighteen cases out of twenty-four. (1)

[Yes.] Inherited from my father's family. (2) Certainly innate. (3) Love of observation and natural history innate. (4) Homology innate. (5) I believe I inherited my general taste for scientific pursuits. (6) Thoroughly innate. Bones and shells were attractive to me before I could consider them with any apparent profit. (7) Innate love of Nature and observation of natural phenomena. (8) I should say innate; I caught at all scraps of lessons for self-improvement. (9) I cannot recollect the time when I was not fond of animals, and of knowing all I could learn about them. (11) Love of birds and their study. . . . I feel that I must have had a taste for science independently of external circumstances. (12) My taste [for science] was entirely innate. (13) As a boy, I had a passion for mechanical contrivances; [my scientific tastes are] altogether innate. (14) I was always fond of construction; my turn for scientific inquiry led me in early life to systematize the knowledge of others. (15) Largely inherited from my father. (17) They appear to have been inherited. (18) Nearly in an equal degree the mixed result of a natural bias and education. (19) I should have been an observer of animal life under whatever conditions I might have lived. (20) I believe my interest in zoology to have been innate.

Botany.—Eight cases out of ten. (1) My scientific es were inborn. (2) As far as the word applies in any case, I should say decidedly innate. (3) Always fond of plants. (4) Was always fond of objective and experimental knowledge. (5) As a youth, I followed, of my own free-will, chemistry and other sciences. (6) A taste for natural science, especially botany, seems to have been innate. (7) [Scientific tastes apparently innate.] (8) A natural inclination.

Medical Science.—Only two cases out of seven. (1) Innate in a great degree. (2) I conclude the tastes were innate, as they showed themselves the moment the opportunity for developing them occurred.

Statistics.—Three cases out of six. (1) Certainly my scientific tastes appear to me to have been, so to say, innate. (3) Innate, I think. (4) Much inclined to think there was an innate tendency

Mechanical Science.—At least two cases out of five. (1) If any tastes be innate, mine were; they date from beyond my recollection. (2) Decidedly innate.

INSTANCES OF TASTES BEING DECIDEDLY NOT INNATE.

Physics and Mathematics.—One case out of twenty. (15) I am not aware of any innate taste for science.

Chemistry.—One case out of eleven. (10) I did nothing serious till the age of twenty-three. My pursuit of chemistry is entirely due to circumstances occurring after manhood.

Zoology.—Three cases out of twenty-four. (16) I doubt much their innate character. (22) I do not consider them innate, but induced. (24) Not at all innate.

Botany.—One case out of ten. (10) Not innate.

Medical.—Four cases out of seven. (3) Not at all especially innate. (4) I cannot perceive that they were innate. (6) I cannot say that I had naturally a turn for any pursuit in particular. (7) Accidentally [directed] to medicine.

Statistics.—One at most out of six. (2) My interest in science was due to my having been officially employed in a statistical inquiry. [It is with much hesitation that I consent to enter this as a case of "not innate."]

SUMMARY OF RESULTS AS TO INNATE TASTES.

	Total Cases.	Decidedly innate.	Decidedly not innate.	Doubtful.
Physics and Mathematics.	20	12	1	7
Chemistry and Mineralogy	11	5	1	5
Geology................	8	7	0	1
Biology—Zoology	24	17	3	4
Botany........	10	8	1	1
Medical Science.	7	2	4	1
Geography (not discussed separately)...........	0	0	0	0
Statistical Science.......	6	3	1	2
Mechanical Science......	5	2	0	3
	91	56	11	24

A mere glance at the table and at the foregoing extracts will probably be enough to convince the reader that a strong and innate taste for science is a prevailing characteristic among scientific men; also that the taste is enduring. This latter peculiarity is by no means a necessary consequence of the former; on the contrary, the ruling motives in the disposition of a man usually change as he grows older, the love of inquiry in childhood being superseded by the fierce passions of youth, and these by the ambitions of more mature life. But a special taste for science seems frequently to be so ingrained in the constitution of scientific men, that it asserts itself throughout their whole existence. Obviously it must have had great influence in directing their early studies and in insuring their successful prosecution of them in after-years.

It would be a curious inquiry to seek the limits of a special taste—that is, the diversity of the objects, any one of which would satisfy it. I think the indications are clear that the tastes of some of my correspondents are far more special than those of others, and that the latter have checked a tendency to desultoriness by their strength of will, or have had it checked by the necessities of their position as professors or professional men; or, most of all, by the possession of that strange quality which the phrenologists call adhesiveness, but which seems to defy analysis. It exists in very different strength in different persons, and I know not where to find a better illustration of its power than in the ordinary case of a man falling in love for the first time. Few lookers-on will doubt that almost any young man is capable of falling in love with any one of at least one-third of the presentable young women of his race and social position, if they happen to see much of one another under favorable circumstances and without other distraction; yet, although the innate taste is of so general a character, it becomes specialized at once by the mere act of falling in love. Then the image of one woman takes complete possession of his thoughts; she is for a considerable period the only female who has attractions for him, although he might previously have been equally attracted by any one of tens of thousands of her sex.

A strong taste bearing remotely on science may prove very helpful. The love of collecting, which is a trifling tendency in itself, common to children, idiots, and magpies, often leads to the study of the things collected, and is of immense use to a man who wishes to study objects that must be collected in large numbers. I have been told of an astronomer whose primary taste was a love of polished brass instruments and smooth mechanical movements; that nothing satisfied this taste so fully as work with telescopes; and from loving the instruments, he soon learned to love the work for which were used. A taste for careful drawing works well neering and into systematic botany or zoology.

A love of adventure and field sports may be an extremely useful element in the character of a man who follows geology or zoology.

As a rough numerical estimate, it seems that six out of every ten men of science were gifted by nature with a strong taste for it; certainly not one person in ten, taken at hap-hazard, possesses such an instinct; therefore I contend that its presence adds fivefold at least to the chance of scientific success. The converse way of looking at the question gives a similarly large estimate. Certainly one-half of the population have no care for science, and an extremely small proportion of that half succeed in it. Nay, further, it appears (though I cannot publish facts in evidence, without violating my rule of avoiding personal allusions) that of the men who have no natural taste for science and yet succeed in it, many belong to gifted families, and may therefore be accredited with sufficient general abilities to leave their mark on whatever subject it becomes their business to undertake. We may therefore rest assured that the possession of a strong special taste is a precious capital, and that it is a wicked waste of national power to thwart it ruthlessly by a false system of education. But I can give no test which shall distinguish in boyhood between a taste that is destined to endure and a passing fancy, further than by remarking that, whenever the aptitudes seem hereditary, they deserve peculiar consideration.

Instinctive tastes for science are, generally speaking, not so strongly hereditary as the more elementary qualities of the body and mind. I have tabulated the replies, and find the proportion to be one case of inheritance to four that are not inherited from either parent. There is no case in which the correspondent speaks of having inherited a love of science from his mother; though, of course, she may, and probably has, often transmitted it from a grandparent. I have a curious case among the returns sent to me, of a passion for heraldry characterising a great-nephew and a great-uncle, the latter of whom had died before the former was born. I have another of an eminent statistician, in whom a love of figures and tabulation was highly characteristic of his grandparent, and is very strongly marked in himself, but was wholly absent in his parent and all other known members of his small family. There have been numerous and most curious cases of a love of figures and tabulation in my own family, which richly deserve a full description. It was carried to so strange an extravagance by one of its members, a lady now deceased, that I can do no sufficient justice to her peculiarities by speaking in general terms; I ought to give pages of anecdotes.

§ 11.—FORTUNATE ACCIDENTS.

come to a group of cases which imply a
nance, namely, where a life-long pursuit
ined by some small accident. The

previous indifference or equilibrium of the mind was unstable, a push was accidentally given, its position was wholly changed, and it rested in one of stable equilibrium. These cases are not numerous—only ten altogether—but I put them in the second place on account of their affinity to those in the first.

Physics and Mathematics.—(19.) [Refer to this.]

Chemistry.—(1) Possession of a chemical box when I was a little boy. (3) From lectures I attended when a boy. (9) To reading by accident a book on chemistry.

Geology.—(2) Fossiliferous rocks near the school where I was.

Zoology.—(9) A traveling fellowship. (16) Accidentally reading a book brought me back to scientific studies, previously suspended owing to my profession. (22) Gift, when a boy, of a box of British shells, with a book to explain them.

Botany.—(10) Accidental receipt of De Candolle's "Flore française," when residing in France.

Medical Science.—None.

Statistics.—(4) Very clear occasional lectures when a boy.

Mechanics.—(2) A particular study at a university, which accidentally became of professional importance.

§ C.—INDIRECT MOTIVES OR OPPORTUNITIES.

This group has also considerable affinity to group (A), and has been alluded to in the remarks appended to the extracts referring to it. It includes those cases in which the mind was partly, but not largely, deflected from its natural bent; that portion of the innate tendency which admitted of being "resolved in the direction" of the scientific pursuit being satisfied, the remainder being wasted. These cases are not numerous—only sixteen altogether—but I give them the third place for the same reason that I gave group (B) the second.

Physics and Mathematics.—(5) Possession of special instruments. (8) Choosing engineering as a profession, but not following it. (19) Love of yachting (leading to researches on magnetism of ships).

Chemistry.—(6) The obtaining of correct and accurate results in chemical analysis gave me great satisfaction.

Geology.—(1) Interest in discoveries made in . . . . (3) A very early love of experiment and chemistry. (6) Should have followed chemistry and physics, but circumstances . . . . gave opportunities for geology.

Zoology.—(5) My choosing . . . . for special inves- n was due to a positive fascination from the obscurity of the subject. (9) My father's and brother's pursuit of field sports, and thence indirectly to natural history. (13) An early passion for mechanism, which led me to take to physiology and anatomy, as the engineering side of my profession. (15) My taste for biology began with keeping insects. (24) . . . . subsequently to the desire to investigate certain questions bearing on medicine.

Botany.—None.

Medical Science.—(3) Connection of hospital and medical school with the place of his residence. (4) Love of facts and the impression that good surgery is a great fact.

Statistics.—None.

Mechanics.—(3) Profession fell in with natural tastes, such as sketching. (4) Innate faculties, serviceable to profession under the pressure of circumstances.

§ D.—PROFESSIONAL DUTIES.

The fourth group comprises instances in which professional duty was a principal cause of the interest first felt in scientific pursuits, or else of the energies being concentrated upon some branch of science toward which no special inclination had previously been exhibited. Two or three of the twenty-one cases which I shall quote may perhaps be thought doubtful examples, and more appropriate to the preceding group; but after all possible deductions have been made, there will remain ample evidence of the magnitude of the influence we are considering. A wise administrator, desirous, even at some cost, of promoting original investigation, would establish many professional offices of a scientific character, having responsible duties of a prominent kind attached to them. They would create much new interest in science, and would compel those who held them to work steadily and to a purpose in scientific harness.

Physics and Mathematics.—(4) Had never attended *specially* to physics till appointed professor of natural philosophy. This induced me to give up chemistry, and to devote myself definitively to physics. (9) Solitary observing for years [as director of an observatory]. (13) Professional duties and civil engineering . . . .; official exploration of . . . . (14) Largely determined by service in north-polar and equatorial expeditions. (15) My interest in astronomy was very small indeed, until I was appointed [to the directorship of an observatory].

Chemistry.—(8) The university inviting me to fill the chair of . . . ., gave my work its bent.

Geology.—None.

Zoology.—(1) Largely determined by being appointed . . . . (10) Partly by my selection of medicine as a profession. (13) My appointment to a surveying-ship made me a comparative anatomist . . . ., that to . . . . forced me to paleontology. (17) First began to concentrate energies to one branch, when appointed . . . . (18) [My scientific tastes] were determined by professional study. (23) To the profession of medicine [in physiology, anatomy, and . . . .] (24) Subsequently to my desire to investigate certain subjects bearing on [my profession of] medicine.

Botany.—(7) Never took up botany to any extent till the professorship was vacant. [There is some conflict of testimony here.]

Medical Science.—(1) Partly to my profession. (2) I selected the medical profession because it was that of my father; this choice led me to scientific pursuits. (3) I did not follow my own branch from any special liking—indeed, I rather disliked it—but it was necessary to earn a livelihood and to follow some branch. (6) My addiction to medicine was purely the result of accident; I never gave a thought to physic as a subject of study until I was twenty-seven years old. (7) Accidental to medicine.

Statistics.—(2) Due to official employment when young, in a very important statistical inquiry.

Mechanics.—(2) The science of . . . ., which I had learned accidentally, became serviceable to me when employed as an engineer. (3) My profession fell in with my natural tastes. (4) Pressure of circumstances.

§ E.—ENCOURAGEMENT AT HOME.

Nearly one-third of the scientific men have expressed themselves indebted to encouragement at home. They received it in various ways; sometimes the influence of the parent was strong and direct, as "their origin was due beyond all doubt to my father's influence;" sometimes it was strong but general, as "I was in a general atmosphere of scientific thinking and discussion;" sometimes it went no further than indulgence, as "permission to carry on little experiments at home in a room set apart for the purpose." Under each and all of these shapes it was truly welcome, and its effectiveness may be in some measure estimated by the vastly smaller number of cases in which success was obtained in direct opposition to family influences.

Scientific studies in boyhood are apt to meet with scant favor at home; they deal too much in abstractions on the one hand, and sensible messes and mischief to furniture and clothes on the other. They lead to no clearly lucrative purpose, and occupy time which might be apparently better bestowed. These hinderances were far more seriously felt when the men on my list were young, when apparatus was hardly to be procured, and when scientific work was exceptional. I ascribe many of the cases of encouragement to the existence of an hereditary link; that is to say, the son had inherited scientific tastes, and was encouraged by the parent from whom he had inherited them, and who naturally sympathized with him.

Attention should be given to the relatively small encouragement received from the mother. I have sorted the extracts so as to permit the comparison to be easily made. The female mind has special excellences of a high order, and the value of its influence in various ways is one that I can never consent to underrate; but that influence is toward enthusiasm and love (as distinguished from philanthropy), not toward calm judgment, nor, inclusively, toward science. In many respects the character of scientific men is strongly anti-feminine; their mind is directed to facts and abstract theories, and not to persons or human interests. The man of science is deficient in the purely emotional element, and in the desire to influence the beliefs of others. Thus I find that two out of every ten do not care for politics at all; they are devoid of partisanship. They school a naturally equable and independent mind to a still more complete subordination to their judgment. In many respects they have little sympathy with female ways of thought. It is a curious proof of this, that in the very numerous answers which have reference to parental influence, that of the father is quoted three times as often as that of the mother. It would not have been the case, judging from inquiries I elsewhere made, if I had been discussing the antecedents of literary men, commanders, or statesmen, or, still more, of divines.

Physics and Mathematics.—(10) The origin of my interest in . . . . is mainly due to my father's knowledge of geology, navigation, and engineering. (11) Primarily derived [both by education and inheritance] from my father.

Chemistry.—(3) Permission to carry on little experiments at home, in a room set apart for the purpose. . . . Subsequently residing abroad and my mother making a home for me there. (4) I was taught at home with my brothers; we had always the example of industry, and were encouraged to think for ourselves. (8) My father gave me [some books on chemistry, and] I owe to my mother a child's curiosity and afterward a man's reverence for scientific truth. (11) My tastes received no encouragement whatever from relations, my mother excepted.

Geology.—(1) My father and an aunt collected specimens. (4) I was indebted in a high degree to collections ade by my father and mother. (7) I was encouraged e example of an elder brother.

Zoology.—(9) (The example of my father and elder brothers, who were all pretty firm to field sports, was also followed by me, and from field sports to field natural history is but a step.) (15) Largely inherited from my father. I was in a general atmosphere of scientific thinking and discussion. (21) I may have derived [? inherited] the tendency from my mother; I belonged to an industrious family, and saw every one working. (1) [Traditionally derived, and] inherited from my father's family [i. e., from father, grandfather, etc.]. (6) My father had no scientific knowledge, nevertheless he encouraged me. (7) I trace it to the love of truth and of mental cultivation in my father, and to his encouragement of this love in his children. (11) That I inherited a strong love of Nature from my father is certain, who was devoted to horticulture and very fond of birds. (16) Their origin was due, beyond all doubt, to my father's influence. (17) My interest in science arose from the example of my father, and . . . ., etc. (19) I trace it to the earliest impressions of my childhood, all of which are connected with my father and the animals he brought me as pets. (23) To my father's example (in science). (4) Decidedly to my mother's observations in our childhood rambles. (8) My soon-developed enthusiasm must have been derived from my mother's family.

Botany.—(2) A little encouragement at home. (6)

The love of botany was instilled into me in very early youth by my father. (8) To my father's encouragement of a natural inclination. (10) And to encouragement from my mother.

Medical Science.—(1) [Partly] to my mother's mental activity and love of collecting and arranging, and to my father's constant encouragement of my pursuit.

Statistics.—(5) [Partly] acquired from intercourse with my father and . . . .

Mechanics.—(5) I was always brought up in a half-scientific, half-literary atmosphere. (3) Family tradition derived through my mother's side.

Two cases are mentioned in which the origin of the scientific tastes was partly due to the active assistance of the wife. One of these is botany (5), and the other I have ventured to suppress, as it did not appear to me sufficiently decided.

§ F.—THE INFLUENCE AND ENCOURAGEMENT OF FRIENDS.

This group has much in common with that of the indirect influences already classed under group C; it includes cases where a fortuitous acquaintance has been means of deciding a career, probably by revealing a taste, or showing how some obstacle in the way of indulging it could easily be removed. There is a wide interval, often very difficult to get over, between the study of a subject out of books and the practical investigation of it for one's self. At this point of a man's mental progress the help of a friend may be of immense assistance; he may give elementary hints which will remove formidable difficulties to a beginner, who is utterly unused to experiment. It is told, I think, of a scholar, that he labored for successive days to make with his own hands in his own chambers a plum-pudding according to a time-honored family recipe, but he produced nothing except thick pastes or stirabouts of different degrees of lumpiness, revolting to the sight. At length he confided his difficulties to a lady, who explained that in making plum-puddings it was a matter of course, and therefore not spoken of in the recipe, to put the ingredients into a bag before beginning to boil them. The example of a friend encourages a young man to overcome his diffidence, and to firmly occupy any position that he knows by his own judgment to be true. Perhaps the greatest help of all is the consciousness of strength which is given by coöperation on not very unequal terms with a veteran in performance and reputation. Out of the ninety-one cases, eighteen speak gratefully of the influence and encouragement of friends.

Physics and Mathematics.—(3) . . . . I was both his young friend and assistant for three years. He imbued me with his respect for science, ... , earnestness, and accuracy. (6) Partly encouraged by an eminent friend. (10) Picked up an unsystematic education [in science] in the company of . . . . (16) I was taken to see . . . . [which was the origin of my experimentalizing]. (17) I trace it to my acquaintance with . . . . , and to going abroad with him. (24) The intimacy of his father with . . . . gave a bias toward magnetism.

Chemistry.—(2) My taste for zoology arose through friendship with . . . .

Geology.—(2) The surgeon to whom I was articled fostered my tastes. (4) To mining officers in Germany; to conversations with . . . . and . . . . , and acquaintance of . . . . (5) Through the acquaintance of . . . . , to the particular branch [of geology, that I have pursued].

Zoology.—(18) The help of . . . . has aided me immensely. (20) I was much under the influence of a remarkable man, a most accomplished naturalist. (23) The example of many men whom I knew when I was young, proved a great stimulus and incentive. (24) I can trace it distinctly to my intercourse with certain professors.

Botany.—(3) . . . . was subsequently encourage by [eminent botanists]. (9) I was thrown into the soci ety of a gentleman who took much interest in botany. (10) They were determined afterward by . . . ., and the friendship and encouragement of the four greatest British botanists of the day.

Medical Science.—(1) [Partly] to the friendship of three eminent botanists. (7) Accidentally [directed] to medicine by associating with a medical friend in a superficial study of botany.

Statistics.—(5) [Partly] from intercourse with my father and certain of his friends.

Mechanical Science.—(2) The friendship of . . . . materially influenced my career.

§ G.—INFLUENCE AND ENCOURAGEMENT OF TUTORS.

This group of thirteen cases refers to the influence and encouragement of masters, tutors, and professors. It is a small one; not because persons in those positions are incapable of exerting much salutary influence, but because the scientific men on my list seldom had the advantage of receiving congenial instruction. This is clearly proved by a comparison of the replies referring to Scotch and to English tuition. In Scotland, the university programme and the general method of teaching are much more suited to men of a scientific bent of mind than those in England; consequently the influence of tutors has been testified to far more abundantly by those men on my list who have been educated in Scotland than by the rest. The proportions are striking and instructive. I find that about one-sixth of those from whom I have received returns have studied in Scotland; hence, if professorial influences had been equally efficacious on both sides of the Tweed, there would have been five times as many expressions of gratitude to English teachers as to Scotch. But the facts show that no less than eight out of the thirteen cases refer to teachers in Scotland, one to a Scotch teacher settled in England, and only four to English professors. It would have been (8 × 5 =) 40, and not 4, if the English education had been as profitable to science as the Scotch. I willingly admit that the smallness of the numbers, namely, only thirteen cases, renders precise figures open to question; however, the superiority of the Scotch system is supported by other evidence, which I shall speak of in the chapter on Education.

Physics and Mathematics.—(7) I believe the origin was when I attended the natural philosophy classes at . . . . (10) Tastes confirmed by lectures, and especially by the encouragement of [certain professors].

) Interest in mathematics due to the encourage-
of . . . ., and influence of [professors at a uni-

Chemistry.—(7) Chiefly to being sent as a pupil to an eminent man of science.

Geology.—(5) Lectures by . . . .

Zoology.—(5) My scientific tastes were largely promoted by the attractive teaching of . . . . [various professors]. (17) And to being the assistant and close companion of . . . . (24) I can trace it [in part] distinctly to my intercourse with certain professors.

Botany.—(4) I date my first efforts of any consequence from an early intimacy with . . . ., whose pupil and assistant I was; the necessity of accurate work then dawned upon me. (6) The companionship of . . . . incited me to prosecute botany with vigor; I was one of his best pupils, and traveled with him.

Medical Science.—(4) Subsequently, by the approval of teachers, having been selected chief-assistant.

Statistics.—(4) Very clear occasional lectures, when a boy, on moral and economical subjects; the tastes were afterward developed by a good education. (6) Prof. . . . .'s lectures were the origin of my interest in geology. [It was the earliest scientific pursuit of this correspondent.]

Mechanical Science.—None.

§ H.—TRAVEL IN DISTANT PARTS.

There are only eight cases in this group, namely, those in which the aspects of Nature under new conditions have developed a love for science. Few men of scientific training have had opportunities of distant travel, but on those few their action has been very strong, especially as regards biologists and physicists. I say nothing here in respect to mere geographers, and quote none of their replies, because its importance to them requires neither proof nor comment. Men are too apt to accept as an axiomatic law, not capable of further explanation, whatever they see recurring day after day without fail. So the dog in the back-yard looks on the daily arrival of the postman, butcher, and baker, as so many elementary phenomena, not to be barked at or wondered about. Travel in distant countries, by unsettling these quasi-axiomatic ideas, restores to the educated man the freshness of childhood in observing new things and in seeking reasons for all he sees.

I believe that a handsome endowment of traveling fellowships, thoroughly well paid, with extra allowance for any special work allotted to their holders, given only to young men of high qualifications, and lasting for at least five years, would be money well bestowed in the furtherance of science.

Physics and Mathematics.—(3) To some extent my tastes were determined by events after manhood, because for ten years I held positions of great responsibility [in distant parts of the world], but I consider they were formed in my youth. (9) Ocean-voyaging in the beginning of life; solitary observing for years in a country verging on a desert under southern skies. (13) The distinct origin . . . . was the wonderful effect produced on me by the aspects of Nature, as seen in the . . . ., combined with what I may call the accident of having been allowed to explore part of it in an official capacity. (14) Largely determined by my service in north-polar and equatorial expeditions.

Chemistry.—None.

Geology.—(7) Subsequently much influenced by being thrown, at the age of nineteen, on my own judgment and resources in founding a mining colony in the backwoods of . . . ., and carrying it out quite alone.

Zoology.—(2) Strongly confirmed and directed by the voyage in the . . . . (13) My appointment to the surveying-ship . . . . made me a comparative anatomist, by affording opportunities for the investigation of the structure of the lower animals.

Botany.—(5) They were directed to botany purely through accidental circumstances [which led to a prolonged residence in an imperfectly civilized country].

§ Z.—UNCLASSED RESIDUUM.

We now come to the final group, namely, those influences which cannot be sorted into any of the eight groups with definite titles, which we have already examined. At the outset I spoke of these unclassed conditions as forming a class by themselves of no great importance, and which might be indefinitely reduced in proportion as we chose to pursue our analysis. I estimate that the ninety-one replies which I have received and analyzed assign a total of one hundred and ninety-one causes. It now appears that no less than one hundred and eighty-eight of these fall into one or other of eight definite groups, and that there remain only three on our hands for the unclassed residuum. Even these are apparently due to aggregates of conditions, the more important of which would probably find their place among the eight groups, leaving a still minuter residue. We may lightly dismiss them as of inappreciably small importance in our present inquiry.

Chemistry.—(10) Entirely due to circumstances after manhood, and in direct opposition to family influences. (11) To opportunity at [a foreign university].

Geology.—(8) The tastes developed gradually after nhood.

SUMMARY.

If we take a general survey of our national stock of capabilities and their produce, we see that the larger part is directed to gain daily bread and necessary luxuries, and to keep the great social machine in steady work. The surplus is considerable, and may be disposed of in various ways. Let us now put ourselves in the position of advocates of science solely, and consider from that point of view how the surplus capabilities of the nation might be diverted to its furtherance. How can the tastes of men be most powerfully acted upon, to affect them toward science?

The large category (A) of innate tastes is practically beyond our immediate influence; but, though we cannot increase the national store, we need not waste it, as we do now. Every instance in which a man having an aptitude to succeed in science is tempted, by circumstances which might be controlled, to occupy himself with subjects of less national value, is a public calamity. Aptitudes and tastes for occupations which enrich the thoughts and productive powers of man are as much articles of national wealth as coal and iron, and their waste is as reprehensible. Educational monopolies which offer numerous and great prizes for work of other descriptions, have caused enormous waste of scientific ability, by inducing those who might have succeeded in science to spend their energies with small effec congenial occupations. When a pursuit is instinctive and the will is untaxed, an immense amount of work may be accomplished with ease. Witness, to take an extreme case, the sustained action of the wholly involuntary muscles. The heart does its work unceasingly, from birth to death; and it is no light work, but such as the arm, working a pump-handle, would soon weary of maintaining. Or again, think of the migratory flight of birds in obedience to an instinct; or of the muscular force, astonishing both in magnitude and endurance, exhibited by lunatics, who have some real though morbid passion which goads them to exercise it. We must therefore learn to respect innate tastes, which directly, as in A, or indirectly, as in C, serve the cause of science. As regards B (the fortunate accidents), we can multiply opportunities. There is great hope in respect to D (the professional influences). It is clear to all who have knowledge of the scope of modern science, that there exists an immense deal of national work which has to be performed, and which none but men of scientific culture are qualified to undertake. Scientific superintendence is required for all kinds of technical education, for statistical investigations of innumerable kinds, and deductions from them; for sanitary administration in the broadest sense; for agriculture, mining, industrial occupations, engineering. There is everywhere a demand for ific assessors, who shall discover how to economize and find out new processes and fruitful principles.

Professional duties generally ought to be more closely bound up with strictly scientific work than they are at present; and this requirement would tend to foster scientific tastes in minds which had little inborn tendency that way. In respect to G (the influence and encouragement of tutors), seeing how far Scotland has surpassed England in the attractiveness of her mode of teaching, which is by professorial lectures rather than by class-work, it is clear that the English system admits of being greatly improved, and the influence of her teachers proportionately increased, in turning the minds of youths to science. Lastly, as regards H (travel in distant lands), its indirect value deserves far more than the moderate sums assigned to its prosecution, in the way of starved traveling fellowships and rare voyages of surveying-ships.

To sum up in a few words: it seems to me that the interpretation to be put on the replies we have now been considering, is that a love of science might be largely extended by fostering, and not thwarting, innate tendencies, by the extension of scientific professional appointments and professorships, by assimilating in some cases the English system of teaching to that of the Scotch, and by creating traveling and other fellowships which shall enable their holders to view Nature in various aspects, and to work with foreigners whose habits of thought are fruitful in themselves, but of a different kind to our own.

I will take this opportunity of drawing attention to what appears to me one of the greatest of desiderata of this kind at the present day, namely, the establishment of medical fellowships amply sufficient to enable the best youths, who intend to follow medicine as a profession, to spend their early manhood in prosecuting independent medical researches. I appeal to capitalists, who know not what use, free from abuse, to make of their surplus wealth, to consider this want. They might greatly improve the practical skill of the English medical profession by affording opportunities of prolonged study. They might, perhaps, themselves reap some part of the benefit of it. A young medical man has now to waste the most vigorous years of his life in miserable routine work simply to obtain bread, until he has been able to establish his reputation. He has no breathing-time allowed him; the cares of mature life press too closely upon his student-days to give him the opportunities of prolonged study that are necessary to accomplish him for his future profession.

The influences we have been considering are those which urge men to pursue science, rather than literature, politics, or other careers; but we must not forget that there are deep and obscure movements of national life, which may quicken or depress the effective ability of the
ion as a whole. I have not considered the reasons
ne period is more productive of great men than
my inquiry being limited, for the reasons stated

in the first pages of this book, to one period and nation. But it may be remarked that the national condition most favorable to general efficiency is one of self-confidence, and eager belief in the existence of great works capable of accomplishment. The opposite attitude is indifferentism, founded on sheer uncertainty of what is best to do, or on despair of being strong enough to achieve useful results; a feeling such as that which has generally existed in recent years among wealthy men in respect to pauperism and charitable gifts. A common effect of indifferentism is to dissipate the energy of the nation upon trifles; and this tendency seems to be a crying evil of the present day in our own country. In illustration of this view, I will quote the following extract from a letter of one of my correspondents, who, I should add, is singularly well qualified to form a just opinion on the matter to which he so forcibly calls attention: "The principal hinderance to inquiry and all other intellectual progress, in the people of whom I see much, is the elaborate machinery for wasting time which has been invented and recommended under the name of 'social duties.' Considering the mental and material capital of which the richer classes have the disposal, I believe that much more than half the progressive force of the nation runs to waste from this cause."

A great deal of energy is wasted in attempting to seize more than can be grasped. There is a feverish tendency, fostered by the daily press, to interest one's self in all that goes on, which leads to perpetual distraction, and curtails the time available for serious and sustained effort. It may be worth while to mention a curious little morbid experience of my own, as suggestive of much more mischief; it is this: A few years ago I had foolishly overworked myself, as many others have done, misled by a perverted instinct, which goaded to increased exertion instead of dictating rest. The consequence was, that I fairly broke down, and could not for some days even look at a book or any sort of writing. I went abroad; and, though I grew much better and could amuse myself with books, the first town where I experienced real repose was Rome. There was no doubt of the influence of the place—it was strongly marked; and for a long time I sought in vain for the reason of it. At last, what I accept as a full and adequate explanation occurred to me—simply, that there were no advertisements on the walls. There was a picturesqueness and grandeur in its streets which sufficed to fill the mind, and there were no petty distractions to fret a weakened eye and brain. When we are in health we take little count of the racket of English life, which may keep apathetic minds from stagnation, but which causes needless wear and tear to active ones, suggesting nothing useful, and teasing, distracting, and wearying. I have heard German professors speak with wonder at our waste of ener- in mere fidget, and in so-called amusements, which tly very dull, and ascribe the successful laboriousness of their own countrymen to the greater simplicity of the lives they lead; and they are a happier people than we are.

Partial Failures.—We have seen that energy, health, steady pursuit of purpose, business habits, independence of views, and a strong innate taste for science, are generally combined in the character of a successful scientific man. Probably one-half of the men on my list possess every one of these qualities in a considerable, and some in a high degree. If one or more of these qualities be deficient, success becomes impossible, unless its absence be appropriately supplemented by other qualities or conditions. Cases may be specified in which too few of the above-mentioned qualities were present, and which consequently ended in an abortive career. One is the possession of energy, health, and independence of character in excess, and little else to control them. These are dangerous gifts. Those who have them are apt to renounce guidances by which the great body of mankind move safely, and to follow out a career in which they are almost certain to blunder and fail egregiously. Probably every large emigrant-ship takes out many such men, full of unjustifiable self-confidence, who, to use a current phrase, "knock about in the world," waste their health, youth, and opportunities, and end broken-down. Another case is that in which a strong innate taste for science is accompanied by independence of character and steadiness of pursuit, but with no other quality helpful to success, and which therefore leads to no useful result. There is hardly a village where some ingenious man may not be found, who has ideas and much shrewdness, but is crotchety and impracticable. He wants energy and business habits, so he never rises. Many of these men brood over subjects like perpetual motion: their peculiarities are well illustrated in De Morgan's "Book of Paradoxes." Again, we frequently meet persons of a stamp that justifies the old-fashioned caricature of scientific men, who are absorbed in some petty investigation, utterly deficient in business habits, and noted for absence of mind. Even idiots have often strongly quasi-scientific tastes, as love for simple mechanism, or objects of natural history; and they have, as already remarked, a pleasure in collecting. Madmen have often persistency, as is shown by their brooding on a single topic. We all of us must have met with curious cases of failures, where a mind and disposition that promise much for success never achieve it. It may be that some mental screw is loose, or there is some irreparable weakness of judgment, or some untimely irresolution or rashness: any fault of this kind is sufficient to mar a man's chances when competition is keen. To obtain the highest order of success, two things are wanted: first, the qualities of the man must either be good all round, or else he must be so circumstanced as to be able, when the need arises, to supplement his deficiencies by extraneous help; secondly, he must have some very useful qualities highly developed. It is said that "genius" is required for high success, and there is much talk about what genius is, and on the failures of men of genius; while some persons go so far as to doubt the existence of genius as a separate quality. It appears to me that what is generally meant by genius, when the word is used in a special sense, is the automatic activity of the mind, as distinguished from the effort of the will. In a man of genius the ideas come as by inspiration; in other words, his character is enthusiastic, his mental associations are rapid, numerous, and firm, his imagination is vivid, and he is driven rather than drives himself. All men have some genius; they are all apt, under excitement, to show flashes of unusual enthusiasm, and to experience swift and strange associations of ideas. In dreams, all men commonly exhibit more vivid powers of imagination than are possessed by the greatest artists when awake. Sober, plodding will is quite another quality, and its over-exercise exhausts the more sprightly functions of the mind, as is expressed in the proverb, "Too much work makes a dull boy." But no man is likely to achieve very high success in whom the automatic power of the mind, or genius in its special sense, and a sober will, are not well developed and fairly balanced.

CHAPTER IV.

EDUCATION.

Preliminary—Education praised throughout, or nearly so—Merits in Education—Merits and demerits balanced—Demerits—Summary—Conclusion.

I NOW pass on to the education which the scientific men had in their youth, in the hope that my results may give assistance to those who are endeavoring to frame systems of education suitable to the wants of the day. What I have to say is very partial; it refers solely to the opinions the scientific men entertain of the merits and faults of their own several educations in by-gone days. Their views are remarkably unanimous, considering the very different branches of inquiry they are interested in, and the great dissimilarities in their education.

One-third of those who sent replies have been educated at Oxford or Cambridge, one-third at Scotch, Irish, or London universities, and the remaining third at no
rsity at all. I am totally unable to decide which
ree groups occupies the highest scientific po-

sition: they seem to me very much alike in this respect.

The questions to which the following replies were given were as follows: "Was your education especially conducive to, or restrictive of, habits of observation?" "Was your education eminently conducive to health, or the reverse?" "What do you consider to have been peculiar merits in your education?" "What were the chief omissions in it, and what faults of commission can you indicate?" I also asked for information concerning the places of education, both schools and colleges, and as regards home and self-instruction. The answers were, in some cases, very interesting from their minute elaboration, but I am, of course, restricted on this occasion to a simple treatment of them. I cannot now paint with delicate tints, but must content myself with broad lights and shades. The following answers are extracts, and, in some few cases, abstracts; they convey the general tone of the several replies as nearly as possible.

The groups under which I have sorted them are these:

MERITS:		
Education praised throughout, or nearly so . .	10	replies.
Variety of subjects	10	"
A little science at school	3	"
Simple things well taught	3	"
Liberty and leisure	3	"
Home teaching and encouragement . . .	8	"
Merits and demerits balanced	4	"

DEMERITS:	
Narrow education	32 replies.
Want of system and bad teaching	10 "
Unclassed	4 "
Total	87 "

There are a few cases in which an answer, already given in combination, has been extracted and repeated.

MERITS: EDUCATION PRAISED THROUGHOUT, OR NEARLY SO—TEN CASES.

(1) "Was admirably taught, between the ages of thirteen and sixteen and a half years, to reason, use my own mind, and depend on myself. Was taught to acquire large masses of information by reading. There was a little tendency to a vagrant style of reading, but this was probably neutralized by other influences."

(2) "Well taught in classics and mathematics. If possible, my education should have afforded facilities for the study of the science of observation, but I doubt the practicability of this at school. While a school-boy I taught myself botany, chemistry, etc., under great disadvantages."

(3) "Careful and good early education at home by my mother and father; then, rather strict training by

my father and by my first school-master. Being carefully looked after by my father, and expected to do my best."

(4) "My education was well balanced; it was general and of a very complete kind, including chemistry, botany, logic, and political economy; but three years (between the ages of twelve and fifteen) spent in learning the Latin and Greek grammars were a blank waste of time."

(5) "Education included French, German, logic, natural philosophy, chemistry, besides mathematics. I lived in a house where I saw many people whose interests were of various kinds, and I went to a day-school where I mixed with the boys only when they were fresh and active. Thus I had two outer worlds to balance against each other. On the whole, I had, I think, the greatest degree of freedom possible to a boy."

(6) "Was at school till sixteen years of age, and with a tutor in Germany for six months; after then, technical training and teaching. The education was conducive both to observation and health. Variety of subjects and attention to details. A combination of home and school education, my father having been head-master of the school."

(7) "My father being a school-master, I was at some

sort of school-work nearly all my life, but from the age of twelve I was occupied more in teaching than in learning. My education included the various subjects usually taught in English schools, with something of astronomy, pneumatics, electricity, and mechanics. I learned much in conversation with my father, which chiefly took an instructive form. Was led to think and speak freely; also to engage frequently in domestic discussions on questions of general policy. I had also early access to tools and materials."

(8) "I was fortunate in obtaining at school (between the ages of eight and sixteen) an insight into the phenomena of Nature—a subject entirely ignored at that time in almost all schools. My peculiar bent for experiment was encouraged at home by my mother, and there were peculiar merits in my training under Profs. . . . . at . . . ., and especially in Germany, under . . . ."

(9) "The steadiness with which I was taught, by one eccentric school-master, reading and accurate spelling, clear, neat, and intelligible writing, and quick and accurate computation by all the primary rules of arithmetic. Faults in these several branches were never overlooked, and all competition was for excellence in each; Latin and French were evidently thrown in to please parents.
ing to sea at the age of thirteen, I really think I start-
h the best education I could have had. Compared

with my youthful messmates, some of whom had passed through public schools, I was far their superior in writing (I soon acquired chart-drawing and sketching from Nature), and in calculation of the day's work, and in astronomical observations."

MERITS IN EDUCATION: VARIETY OF SUBJECTS—NINE REPLIES.

(1) "Not tied down to old courses of classics and mathematics."

(2) "My master (between the ages of fifteen and seventeen) was a man of scientific and generally liberal turn of mind."

(3) "Sufficient ground-work in many subjects to avoid error."

(4) "Early introduced to many subjects of interest."

(5) "A well-balanced education [including chemistry, botany, logic, and political economy]."

(6) "A variety of subjects and attention to details. Coming in contact with persons of every rank [in Scoland], and sitting on the same form with the sons of tradesmen and ploughmen, as well as of gentlemen."

(7 and 8) Two cases; both [being Englishmen] praise Scotch system of education.

(9) "Living in a house where there were many interests, and going thence to a day-school, where there were other and different ones."

MERITS IN EDUCATION: A LITTLE SCIENCE AT SCHOOL—THREE REPLIES.

(1) "Only one good thing; that was object-lessons, though given badly, and only for a short time."

(2) "All the merits [of my schooling] I attribute to a little elementary physics and chemistry, taught me between the ages of seven and thirteen."

(3) "Science taught me at school, between the ages of eleven and sixteen."

MERITS IN EDUCATION: SIMPLE THINGS WELL TAUGHT—THREE REPLIES.

(1) "Clear, neat, and intelligible writing, accurate spelling, and simple computation."

(2) "Was very well grounded in arithmetic at school."

(3) "Forced accuracy of delineation at home, be- the ages of fourteen and sixteen."

MERITS IN EDUCATION: LIBERTY AND LEISURE—THREE REPLIES.

(1) "Unusual degree of freedom."

(2) "Freedom to follow my own inclinations and choose my own subjects of study, or the reverse."

(3) "The great proportion of time left free to do as I liked, unwatched and uncontrolled."

MERITS IN EDUCATION: HOME TEACHING AND HOME ENCOURAGEMENT—EIGHT REPLIES.

(1) "Encouragement by my mother."

(2) "Encouragement by my father."

(3) "Carefully looked after by my father, and expected to do my best."

(4) (See (7), in "Education praised throughout, or nearly so.")

(5) "During one year (aged seventeen) I resided and studied with my uncle [by marriage], and learned there more of the dead languages than in all my school-time."

(6) "My private education at home was much the more valuable."

(7) "Home and self-education developed my observing faculties."

(8) "Pretty much self-taught, but encouraged to use my eyes, wits, and independent thought."

MERITS AND DEMERITS IN EDUCATION BALANCED—FOUR REPLIES.

(1) "Left to myself, and I pursued a discursive line. As compared with ordinary schools, I think self-teaching has many advantages for boys of active minds; but intelligent teaching, and insisting on accuracy and completeness, would have produced a much more efficient man."

(2) "The merits of my education consisted in the great number of studies connected with Nature; but there was a want of system and of consecutive study."

(3) "The demerit of my education was the want of being thoroughly grounded; this gave me great trouble, but made me think for myself—often an advantage to me."

(4) "No sound instruction; the education was too general and desultory, but it gave wide interest."

DEMERITS: NARROW EDUCATION—THIRTY-TWO CASES.

(1) "No mathematics nor modern languages, nor any habits of observation or reasoning."

(2) " Enormous time devoted to Latin and Greek, with which languages I am not conversant."

(3) " Omission of almost every thing useful and good, except being taught to read. Latin ! Latin ! Latin ! "

(4) " Latin through Latin—nonsense verses."

(5) " Limitation of subjects practically to classics."

(6) "Absence of any scientific training; too much confined to classics."

(7) " Omission of mathematics, German, and drawing."

(8) " Latin and Greek were more insisted on than modern languages."

(9) " In an otherwise well-balanced education, three years (between the ages of twelve and fifteen) at a private school were spent on Latin and Greek grammar—a blank waste of time."

(10) " School-work directed to the cultivation of literary tastes only, and therefore not adapted to a variety of intellects."

(11) " Elements of natural science omitted; nothing taught of the nature of the world around us."

(12) "Not taught mathematics, nor any natural science, to which I could have taken *con amore*."

(13) "Absence of instruction in the modern languages."

(14) "Want of the modern languages and of chemistry."

(15) "Want of logical and mathematical training."

(16) "Want of training in the habits of observation."

(17) "Neglect of mathematics; too much reliance on mere work of memory. Mental training overlooked in the mere acquisition of routine."

(18) "I could now wish that I had gone through, at the university, a good course of chemistry and physics, as a preparation for the other branches; but the main obstacle was lack of time."

(19) "Want of education of faculties of observation; want of mathematics, and of modern languages."

(20) "Not allowing my mind to follow its natural bias."

(21) "Neglect of many subjects for the attainment of one or two; not pushing mathematics to a useful end."

(22) "Not enough liberty; put back by too much grounding at Cambridge."

(23) "At school the classical education, viz., construing, parsing, and learning grammatical rules, was not to my taste. At Oxford I wasted much time, having little sympathy with the university pursuits and habits."

(24) "Having so exclusively devoted myself to mathematics at Cambridge."

(25) "The classical teaching was said to be good, but I did not assimilate it. Perhaps my mental peculiarities and my special inaptitude to commit words to memory would have rendered most education, such as it was when I was a boy, ineffectual for much good. The main defect for me certainly was that *precise* verbal memory was the test of all knowledge. No doubt in some things, such as languages, precise knowledge of words is essential, and therefore I refer to my own special defect in saying this."

(26) "My school-work was too predominantly classical, and nearly every thing was taught on *authority*."

(27) "Persistence in giving me no holiday, and overstraining my memory when I was very young."

(28) "My principal regret is, that I was u[illegible] pursue the study of mathematics."

(29) "Mathematics were not pushed far enough; natural science was left to the boys themselves."

(30) "My boyhood was utterly wasted, and the efforts of my manhood have not sufficed, and never will suffice, to repair the loss."

(31) "Omission of all subjects excepting the classics, but particularly [faulty] in the want of intellectual training."

(32) [A military man.] "The *authority* of a military education is prejudicial to the development of thought and education in matters of opinion."

DEMERITS IN EDUCATION: WANT OF SYSTEM AND BAD TEACHING—TEN CASES.

(1) "Want of system."

(2) "Want of system."

(3) "Want of system."

(4) "Want of system; absence of necessary control."

(5) "Bad early masters; neglect at public school."

(6) "Essentially defective; no competition nor supervision."

(7) "The very mistaken way in which languages, as it now seems to me, especially Latin and Greek, were taught."

(8) "Too much for memory; nothing for thought."

(9) "Want of thoroughness in early teaching."

(10) "Careless and superficial reading."

DEMERITS IN EDUCATION: UNCLASSED—FOUR CASES.

(1) "Brought up in an idle class, and never realized the necessity of labor in acquirement."

(2) "Too much cramming for examinations. Too much isolated, being the youngest son, and educated at home."

(3) "Too great changes in system, having been educated at five universities (three of which were Scotch, one London, and one in Germany)."

(4) "Being brought up at home; was perhaps too much shut out from the company of other boys."

SUMMARY.

The scientific men on my list have very generally ascribed high merits to a varied education. They say, as we have just seen: "Not tied down to old courses of classics and mathematics."—"Sufficient groundwork in many subjects to avoid error."—"A well-balanced education, including chemistry, botany, logic, and political economy."—"Coming in contact with persons of every rank, and sitting in the same form [in a Scotch school] with the sons of tradesmen and ploughmen, as well as gentlemen." In contrast to this, others, who speak of the faults of their education, say: "No mathematics, nor modern languages, nor any habits of observation or reasoning."—"Enormous time devoted to Latin and Greek, with which languages I am not conversant."—"In an otherwise well-balanced education, three years were spent on Latin and Greek grammar—a blank waste of time."—"Neglect of many subjects for the attainment of one or two; not pushing mathematics to a useful end." Evidence such as this fully establishes the advantage of a variety of study. One group of men speak gratefully because they had it, and another speak regretfully because they had it not. I find none who had a reasonable variety who disapproved of it, none who had a purely old-fashioned education who were satisfied with it. The scientific men who came from the large public schools usually did nothing when there; they could not assimilate the subjects taught, and have abused the old system heartily. There are several serious complaints about superficial and bad teaching which I need not quote afresh. Overteaching is thoroughly objected to; thus, in speaking of merits of education, I find: "Freedom to follow my own inclinations, and to choose my own subjects of study, or the reverse."—"The great proportion of time left free to do as I liked, unwatched and uncontrolled."—"Unusual degree of freedom." There is much scattered evidence throughout the replies to my questions generally, in addition to what I have extracted, which implies that this feeling is a very common one. There are many touching evidences of the strong effect of home encouragement and teaching; of this I have already spoken, and need not dwell upon afresh.

In corroboration of the conclusions stated in p. 162, on the favorable influence of the Scotch system in developing a taste for science, I remark that, in these replies, a large proportion of the scientific men who have mentioned any merits in their education were educated in Scotland.

As regards the subjects specially asked for, even by biologists, mathematics take a prominent place. Two of my correspondents speak strongly of the advantages derived from logic, and the weighty judgment of the late John S. Mill powerfully corroborates their opinions. Accuracy of delineation is also spoken of, and, owing to the extraordinary prevalence of mechanical aptitudes, I believe that the teaching of mechanical drawing and manipulation would be greatly prized.

The interpretation that I put on the answers as a whole is as follows: To teach a few congenial and useful things very thoroughly, to encourage curiosity concerning as wide a range of subjects as possible, and not to overteach. As regards the precise subjects for rigorous instruction, the following seem to me in strict accordance with what would have best pleased those of the scientific men who have sent me returns: 1. Mathematics pushed as far as the capacity of the learner admits, and its processes utilized as far as possible for interesting ends and practical application. 2. Logic (on the grounds already stated, but on those only). 3. Observation, theory, and experiment, in at least one branch of science; some boys taking one branch and some another, to insure variety of interests in the school. 4. Accurate drawing of objects connected with the branch of science pursued. 5. Mechanical manipulation, for the reasons already given, and also because mechanical skill is occasionally of great use to nearly all scientific men in their investigations. These five subjects should be *rigorously* taught. They are any thing but an excessive programme, and there would remain plenty of time for that variety of work which is so highly prized, as—ready access to books; much reading of interesting literature, history, and poetry; languages learned, probably best during the vacations, in the [illegible] and swiftest manner, with the sole object of [illegible] the learner to read ordinary books [illegible] my re- [illegible] much teaching, but rather by awakening their interests, encouraging their pursuits when at home, and leaving them to teach themselves continuously throughout life. Much teaching fills a youth with knowledge, but tends prematurely to satiate his appetite for more. I am surprised at the mediocre degrees which the leading scientific men who were at the universities have usually taken, always excepting the mathematicians. Being original, they are naturally less receptive; they prefer to fix of their own accord on certain subjects, and seem averse to learn what is put before them as a task. Their independence of spirit and coldness of disposition are not conducive to success in competition: they doggedly go their own way, and refuse to run races.

CONCLUSION.

Science has hitherto been at a disadvantage, compared with other competing pursuits, in enlisting the attention of the best intellects of the nation, for reasons that are partly inherent and partly artificial. To these I will briefly refer in conclusion, with especial reference to the very important question as to how far the progress of events tends to counterbalance or remove them.

If we class energy, intellect, and the like, under the general name of ability, it follows that, other circum-
eing the same, those able men who have vigor
r extra-professional pursuits, will be mainly

governed in the choice of them by the instinctive tastes of their manhood. The majority will address themselves to topics nearly connected with human interests; a few only will turn to science. This tendency to abandon the colder attractions of science for those of political and social life, must always be powerfully reënforced by the very general inclination of women to exert their influence in the latter direction. Again, those who select some branch of science as a profession, must do so in spite of the fact that it is more unremunerative than any other pursuit. A great and salutary change has undoubtedly come over the feeling of the nation since the time when the present leading men of science were boys, for education was at that time conducted in the interests of the clergy, and was strongly opposed to science. It crushed the inquiring spirit, the love of observation, the pursuit of inductive studies, the habit of independent thought, and it protected classics and mathematics by giving them the monopoly of all prizes for intellectual work, such as scholarships, fellowships, church livings, canonries, bishoprics, and the rest. This gigantic monopoly is yielding, but obstinately and slowly, and it is unlikely that the friends of science will be able, for many years to come, to relax their efforts in educational reform. As regards the future provision for successful followers of science, it is to be hoped that, in addition to the many new openings in industrial pursuits, the gradual but sure development of sanitary administration and statistical inquiry may in time afford the needed profession. These and adequately paid professorships may, as I sincerely hope they will, even in our days, give rise to the establishment of a sort of scientific priesthood throughout the kingdom, whose high duties would have reference to the health and well-being of the nation in its broadest sense, and whose emoluments and social position would be made commensurate with the importance and variety of their functions.

APPENDIX.

My schedule of printed questions, together with the ample spaces left for replies, filled, I am half ashamed to acknowledge, seven huge quarto pages. It would be a cumbrous addition to a publication like the present to reproduce these in the same form in which they were framed; and as the following extracts (with trifling variations rendered necessary by the change of form) cover precisely the same ground, and are sufficient for explanation, I abstain from doing so.[1]

A circular letter, in which I explained briefly the object of the inquiry, accompanied the schedule, and I appended to it a reprint of a short article which I had written in the *Fortnightly Review* early in 1873, partly to show the interest with which I had pursued cognate inquiries, and partly as a guarantee of the tone and spirit in which the inserted communications would be treated. Also I presumed, and, as it has proved, not without reason, that being more or less personally acquainted with a large majority of the scientific men on my list, they would be inclined to put greater faith in my discretion than if I had been a stranger. Subject to these preparatory explanations, the following are the questions that I circulated:

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[1] I also omit the description of a notation I proposed to replace indefinite words such as "large," "considerable," because I have made no use of it in this volume. It is a modification of the class notation used by me in my "Hereditary Genius," and was alluded to and illustrated in my lecture before the Royal Institution, 1874. I have by no means abandoned its advocacy, but have learned the necessity of explaining and exemplifying it in considerable detail before its merits and convenience are likely to become as generally recognized as I believe they deserve to be.

INQUIRY INTO THE ANTECEDENTS OF SCIENTIFIC MEN.

Please return this schedule at your earliest convenience, with answers to as many of the questions as you consider to be unobjectionable, and send on a separate paper any further information that you may think germane to the inquiry. Entries marked "Private" will be dealt with in *strict confidence;* they will be used only as data for general statistical conclusions.

Note.—Whenever you consider the grade of the quality about which a question is asked to fall near mediocrity, *do not make any entry at all.*

Christian names of yourself, your father, and your mother, er maiden name? Designation and principal titles of yourself, your father, and the father of your mother? Your father and mother, are they respectively English, Welsh, Scotch, Irish, Jewish, or foreign? If foreign, of what country? Wholly or in what degree? Was either your father or your mother descended from persons persecuted for political or religious opinions, or from political or religious refugees? If so, state the precise relationship. Mention whether their political or religious opinions became traditional in the family. Occupation of yourself, your father, and the father of your mother? Specify any interests that have been very actively pursued by them, in addition to their regular occupation or profession.

All the questions in the following paragraph are asked concerning yourself, your father, and your mother respectively:

Date of the birth of? Place of the birth of (if you do not remember that of either your father or mother, state where he or she resided in early life)? Mention if it was in a large or small town, a suburb, a village, or a house in the country. To what religious bodies have you (self, father, and mother) respectively belonged? To what political parties? Health at the various periods of life? In early adult life, what was your height (to be estimated, where not accurately remembered)? Was there any thing distinctive in the figure, etc. (spare, symmetrical, muscular, etc.)? Color of hair? Complexion (if remarkably fair, dark, ruddy, pale, sallow, etc.)? Temperament, if distinctly nervous, sanguine, bilious, or lymphatic? Measurement round inside of rim of your hat? Energy of body, if remarkable; as shown by power of activity, power of enduring fatigue, restlessness, requiring but little sleep (state how much), early rising, adventures, travel, mountaineering, etc. (give a few facts)? Energy of mind, if remarkable; as shown by power of accomplishing a large *amount* of brain-work, by the vigorous pursuit of interests, whatever they may be, etc. (give a few facts)? Retentiveness of memory (give facts)? Studiousness of disposition and mental receptivity, as shown by large acquirements? Independence of judgment in social, political, or religious matters (give illustrations)? Originality or eccentricity of character (give illustrations)? Special talents, as for mechanism, practical business habits, music, mathematics, etc.? Strongly-marked mental peculiarities, bearing on scientific success, and not specified above: the following list may serve to suggest—impulsiveness, steadiness, strong feelings and partisanship, social affections, religious bias of thought, love of the new and marvelous, curiosity about facts, love of pursuit, constructiveness of imagination, foresight, public spirit, disinterestedness.

Are any peculiarities either very uniformly developed, or also very irregularly developed among yourself, your brothers and sisters, or in the family of your father, or in that of your mother?

State the number of males and that of the females in each of the following degrees of relationship who have attained thirty years of age, or thereabouts: Grandparents, both sides; parents, uncles and aunts, both sides; brothers and sisters; first-cousins of all four descriptions; nephews and nieces. In each of these several degrees of relationship, state the names of those who have occupied prominent positions or written well-known works, or who from any other cause may be considered as public characters. State their principal achievements, mention the best biographies, and the most useful among the scattered biographical notices that may exist of them; terms of award of medals, etc. Also, in each of the above degrees of relationship, give the number (with initials or names) of those whose ability *in any respect* was considerable, but who did not become public characters (fuller information to be sent on a separate paper). Similar information is acceptable concerning other more remote degrees of relationship. Brief notes concerning hereditary peculiarities of any kind in your family, bodily or mental, would be acceptable. How many brothers and sisters had you older than yourself, and how many younger?

How long were you at small schools, large schools, universities, and at what ages? Name or place of school or university, and chief subjects taught there. Mention any honors of importance gained by you at schools or universities. To what extent were you educated elsewhere, taught at home, or self-taught? Was your education especially conducive to, or restrictive of, habits of observation? Was it eminently conducive to health or the reverse? What do you consider to have been peculiar merits in it? What were the chief omissions in it, and what faults of commission can you indicate? Has the religion taught in your youth had any deterrent effect on the freedom of your researches? Can you trace the origin of your interest in science in general and in your particular branch of it? How far do your scientific tastes appear to have been innate? Were they largely determined by events occurring after you reached manhood, and by what events?

Have you been married? Year in which you were married? Maiden name of your wife? Number of living sons and daughters (of all ages)? State any facts of peculiar interest in your wife's family.

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